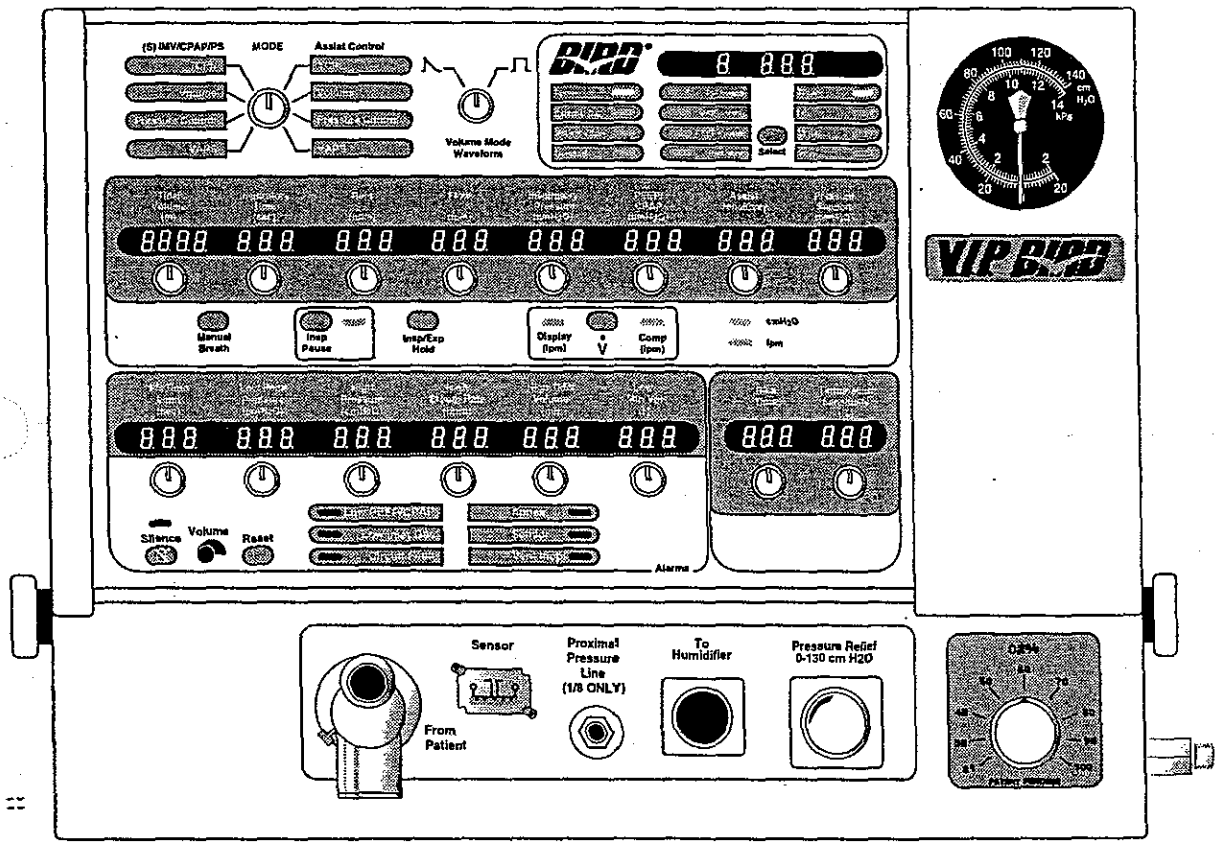
Thermo Respiratory Group

BIRD®

V.I.P. Bird®
Infant Pediatric Ventilator



Service Manual

L1208 Rev. C - 8/99

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ORDERING INFORMATION

Contact your Bird Products Corporation Dealer or Bird Products Corporation **Customer Service Department** directly:

1100 Bird Center Drive
Palm Springs, CA 92262
(760) 778-7200 or
(800) 328-4139
Fax: (760) 778-7274

TECHNICAL INFORMATION

Contact Bird Products Corporation **Technical Service Department** directly:

1100 Bird Center Drive
Palm Springs, CA 92262
(760) 778-7390 or
BIRD HELPLINE
(800) 934-BIRD
[(800) 934-2473)]

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WARNING !

This service manual is intended for use by Bird Products Corporation trained and authorized service personnel. Bird Products Corporation does not condone or approve of service activity on its products by other than Bird Products Corporation trained or authorized personnel. **BIRD PRODUCTS CORPORATION IS NOT RESPONSIBLE FOR ANY UNAUTHORIZED REPAIRS, OR ANY REPAIRS MADE BY UNAUTHORIZED PROCEDURES.**

Use of the incorrect part or the failure to exercise due care in the installation, removal, servicing, checkout or calibration of parts and equipment may result in damage or possible malfunction of the equipment. This may also result in damage to property and injury including death. The purchaser and installer of these parts shall bear full responsibility and liability for the above.

All maintenance performed within the applicable warranty period (see warranty card) must be authorized in advance by Bird Products Corporation service representative in order to retain the warranty status of the subject unit.

Section 1.0
General Information

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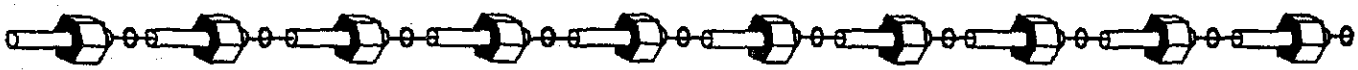
V.I.P. BIRD® Infant-Pediatric Ventilator
Service Manual



V.I.P. SECTION 1.0: GENERAL INFORMATION

1.1 WARRANTY

The products of Bird Products Corporation (Herein Bird) are warranted to be free from defects in material and workmanship and to meet the published specifications for one(1) year.

The liability of Bird under this warranty is limited to replacing, repairing or issuing credit, at the discretion of Bird, for the parts that become defective or fail to meet published specifications during the warranty period; Bird will not be liable under this warranty unless (A) Bird is promptly notified in writing by Buyer upon discovery of defects or failure to meet specifications; (B) the defective unit or part is returned to Bird, transportation charges prepaid by Buyer; (C) the defective unit or part is received by Bird for adjustment no later than four weeks following the last day of the warranty period; and (D) Bird's examination of such unit or part shall disclose, to its satisfaction, that such defects or failures have not been caused by misuse, neglect, improper installation, unauthorized repair, alteration or accident.

Any authorization of Bird for repair or alteration by the Buyer must be in writing to prevent voiding warranty.

Bird warranties as hereinabove set forth shall not be enlarged, diminished or affected by, and no obligation or liability shall arise or grow out of the rendering of technical advice or service by Bird or its agents in connection with Buyer's order of the products furnished hereunder.

- LIMITATIONS OF LIABILITIES

In no event shall Bird be liable to Buyer for loss of profits, loss of use, consequential damage or damages of any kind based upon a claim for breach of warranty, other than the purchase price of any defective product covered hereunder.

This warranty does not cover normal maintenance such as cleaning, adjustment or lubrication and updating of equipment or parts. This warranty shall be void and shall not apply if the equipment is used with accessories or parts not manufactured by Bird or authorized for use in writing by Bird, or if the equipment is not maintained in accordance with a prescribed schedule of maintenance.

The warranty stated above shall extend for a period of one year from date of delivery, with the following exceptions:

1. Electrical components for remote monitoring of physical variables such as temperature, pressure, oxygen saturation or flow are warranted for ninety (90) days from date of receipt.

2. Elastomeric components and other parts or components subject to deterioration over which Bird has not control are warranted for sixty (60) days from date of receipt.

The foregoing is in lieu of any other warranty, expressed or implied, including, without limitation, any warranty of merchantability, except as to title, and can be amended only in writing by a duly authorized representative of Bird.

CSA®
THE MARK OF CONSUMER CONFIDENCE WHEN SAFETY COUNTS

ETL
This product is listed by ETL TESTING LABORATORIES, INC.

V.I.P. SECTION 1:0: GENERAL INFORMATION

1.2 USER RESPONSIBILITY

This product will perform in conformity with the description of it contained in this service manual and accompanying labels and/or inserts, when assembled, operated, maintained and repaired following the instructions provided. This product must be checked periodically A defective product should not be used. Parts that are broken, missing, plainly worn, distorted or contaminated should be replaced immediately. If repair or replacement becomes necessary, Bird recommends that a telephonic or written request for service advice be made to the nearest Bird distributor or the Bird Service Center in Palm Springs, California. This product or any of its parts should not be repaired other than following written instructions provided by Bird and by Bird trained personnel. The user of this product shall have the sole responsiblility for any malfunction that results from improper use, faulty maintenance, improper repair, damage or alteration by anyone other than an authorized Bird representative.

1.3 INTRODUCTION

1.3.1 Description

The V.I.P. BIRD is a state-of-the-art, microprocessor controlled device with an integral monitoring package. Through a variety of modes, the unit allows ventilation of neonatal, infant, and pediatric patients. The ventilator provides the clinician with:

- **IMV/CPAP** with Time Cycled, Pressure Limited Breaths
- **ASSIST/CONTROL** with Volume Limited Breaths
- **SIMV/CPAP** with Volume Limited Breaths
- Pressure Support available in SIMV/CPAP
- Continuous Flow/Demand flow principle for spontaneous breathing in IMV/CPAP
- Demand flow principle for spontaneous breathing in SIMV/CPAP
- 20 to 995 ml. Tidal Volumes
- 0 to 150 BPM
- 3 to 40 LPM PEAK FLOW in Time Cycled Mode, 3 to 100 LPM in Volume Cycled Modes

Description Continued

- Comprehensive monitoring package, including **PEAK INSPIRATORY PRESSURE, MEAN AIRWAY PRESSURE, BREATH RATE, INSPIRATORY TIME, I:E RATIO, LEAK COMPENSATION ON/OFF**
- Comprehensive alarm package.
- Adjustable alarm loudness.
- Fiber Optic data link.
- Optional air compressor

1.3.2 Application

The V.I.P. BIRD is electrically and pneumatically powered and microprocessor controlled. Depending on the mode of operation, it can be time or volume cycled. The unit is pressure cycled only when the **HIGH PRESSURE LIMIT ALARM** is reached. The unit functions as a controller or assistor controller and delivers accurately controlled air/oxygen mixtures at a constant flow. The ventilator can provide positive airway pressure (**CPAP**), and synchronized intermittent mandatory ventilation (**SIMV**). The ventilator can produce peak pressures up to 120 cmH20, and has a tidal volume range in **ASSIST/CONTROL** and **SIMV/CPAP** of 20 to 995 ml. The unit has peak flow capability of 3 to 40 LPM in the Time Cycled Mode and 3 to 100 LPM in the Volume Cycled Modes. These specifications allow the ventilator to address a broad range of neonatal, infant, and pediatric patients.

1.3.3 Definition of Repair – Maintenance

The V.I.P. BIRD Service Manual contains pneumatic and electronic theories of operation, calibration, troubleshooting, replacement, and maintenance instructions to assist a qualified service technician.

The service manual is specifically intended for use by an authorized service person; that is, a person that has attended a V.I.P. BIRD service seminar conducted or authorized by **BIRD'S SERVICE TRAINING CENTER.** Any repairs, adjustments, or procedures that exceed the scope of this manual should be referred to the **BIRD PRODUCT CORPORATION TECHNICAL SERVICES CENTER.** For specific operating instructions and clinical theory of operation, refer to the V.I.P. BIRD Instruction Manual, P/N L1194. Service personnel should become thoroughly familiar with the Operating and Maintenance procedures before attempting service on this equipment.

The **WARNINGS, CAUTIONS,** and **NOTES** should be given particular attention.

Section 4: Maintenance & Service of this manual covers the details related to the diagnosis and repair of defective subassemblies of the V.I.P. BIRD ventilator. This manual is structured around the concept of isolating a problem to a defective subassembly and replacing that defective subassembly.

The manual does not cover diagnosis and repair of, for example, component failures on the printed circuit board subassemblies; however, complete schematic information is provided for the service technician. Defective subassemblies can be replaced in the field by factory trained personnel.

Only factory trained personnel should attempt diagnosis and repair of the V.I.P. BIRD ventilator. Bird's service training classes are based on fault analysis and repair at the subassembly level and also include detailed training on how to perform the 15,000 hour maintenance of the ventilator.

The maintenance schedule for the V.I.P. BIRD ventilator includes preventive maintenance through the first 15,000 hours as follows:

NOTE

Routinely replace any damaged, leaking or worn tubing, adapters, exhalation valve diaphragm, air inlet water trap bowl/o-ring.

Every 1000 Machine Hours:	Replace air inlet filter element
Every 1000 Machine Hours:	Verify transducer calibration
Every 5000 Machine Hours:	Replace NYLON CONE filters in the air and oxygen inlets. Replace the main and proximal bacteria filters. These filters should be replaced more often if the resistance to the flow through the filters exceeds the maximum allowable limit.
Every 15,000 Machine Hours:	**A complete machine maintenance will be required**

Maintenance – Continued

The 15,000 hour maintenance must be done by any factory trained service technician. It is important, however, that the maintenance be done using only the maintenance components provided by Bird Products Corporation. In addition, no maintenance should be considered complete until an Operational Performance Verification test has been performed in accordance with Section 4 of this manual.

All repairs and maintenance, including the 15,000 hour maintenance, can be done at any facility where proper service equipment is available to qualified, trained technicians.

1.4 PERFORMANCE CHARACTERISTICS AND SPECIFICATIONS

BACK PANEL CONTROLS

Control or Parameter	Modes Available In	Range
Power	All	Off/On (I/O)
AC/DC Switch	All	AC Line/12 VDC

FRONT PANEL CONTROLS

Control or Parameter	Modes Available In	Range
Mode		**Time Cycled:** • IMV/CPAP **Volume Cycled:** • Assist/Control • SIMV/CPAP
Tidal Volume	Assist/Control SIMV/CPAP	20 to 995 ml
Inspiratory Time	IMV/CPAP	0.10 TO 3.00 Sec.
Breath Rate	All	0 to 150 BPM
Flow:	IMV/CPAP Assist/Control SIMV/CPAP	3 to 40 LPM 3 to 100 LPM 3 to 100 LPM
High Peak Pressure Limit (see also Alarms))	SIMV/CPAP IMV/CPAP	3 to 120 3 TO 80 cmH_2O
PEEP/CPAP	ALL	0 TO 24 cmH_2O

SECTION 1: GENERAL INFORMATION

Front Panel Controls Continued

Control or Parameter	Modes Available In	Range
Assist Sensitivity	Assist/Control SIMV/CPAP	1 TO 20 cmH_2O, Off
Pressure Support	SIMV/CPAP	Off, 1 to 50 cmH_2O
Manual Breath	All	X1
Oxygen percent	All	21% TO 100%
Over-Pressure Relief	All	0 TO 130 cmH_2O

MONITORS

Control or Parameter	Modes Available In	Range
Proximal Airway Pressure	All	-20 to 140 cmH2O
Peak Inspiratory Pressure	All	0 to 130 cmH_2O
Mean Airway Pressure	All	0 to 120 cmH_2O
Breath Rate	All	0 to 250 BPM
Inspiratory Time	All	0.05 to 60 Sec.
I:E Ratio	All	1:0.1 to 1:60.0
Patient Effort	Assist/Control SIMV/CPAP	Assist Sensitivity met
Demand	IMV/CPAP	Demand System Triggered
Power	All	Indicates Ventilator Power is ON
External DC	All	Indicates External DC Power Source
Hourmeter	All	0 to 99,999 HRS.

ALARMS

Control or Parameter	Modes Available In	Range
High Peak Pressure Limit	Assist/Control	3 to 120 cmH_2O
Pressure Limit	SIMV/CPAP	3 to 120 cmH_2O
Low Peak Pressure	All	FLASHING OFF, 3 to 120 cmH_2O
Low PEEP/CPAP	All	-9 to 24 cmH_2O
High Prolonged Pressure	IMV/CPAP	High Pressure Limit + 10 cmH_2O

Alarms Continued

Control or Parameter	Modes Available In	Range
High Prolonged Pressure Apnea	All Assist/Control SIMV/CPAP	PEEP/CPAP + 6 cmH_2O 20,40,60 Sec.
Low Inlet Gas Pressure	All	<22.5 PSIG 1.58 kg/cm2 or >27.5 PSIG 1.90 kg/cm2
Ventilator Inoperative	All	Voltage Out Of Range System Pressure <20 PSIG 1.4 kg/cm2 or >30 PSIG 2.1 kg/cm2 System Fault
Circuit Fault	All	Patient Circuit Fault Pressure Transducer Fault

OUTPUTS

Control or Parameter	Modes Available In	Range
Data Link	All	High Speed Fiber Optic
Blender Auxiliary	All	0 to 15 LPM

PRE-SET VALUES

Control or Parameter	Modes Available In	Range
Minimum Expiratory Time	All	250 msec.
Minimum Inspiratory Time	IMV/CPAP Assist/Control SIMV/CPAP	100 msec. 150 msec.
Demand Sensitivity	IMV/CPAP	1.0 cmH_2O
Demand Flow	IMV/CPAP SIMV/CPAP	 Maximum 120 LPM
Leak Compensation System Sensitivity Flow Range	Volume Cycled	 0.5 cmH_2O 0 to 10 LPM

SECTION 1: GENERAL INFORMATION

INPUTS

Control or Parameter	Modes Available In	Range
Electrical	All	Fuse Rating 100 VAC+10%-15%, 50/60Hz, 0.75amps-1.25 SB 120 VAC+10%-15%, 50/60Hz, 0.58amps-1.00 SB 220 VAC+10%-15%, 50/60Hz, 0.35amps-0.63 SB 240 VAC+10%-15%, 50/60Hz, 0.32amps-0.63 SB 11.8-16 VDC 5 amps (max.)
Pneumatic	All	40 to 75 PSIG 2.8 to 5.2 kg/cm2 Air and O_2 must be within 20 PSIG 1.4 kg/cm2

PHYSICAL DIMENSIONS & WEIGHT

	Height	Width	Depth	Weight
Ventilator Only	12" (30.4 cm)	15" (38.1 cm)	13" (33 cm)	39 lbs. (17.5 kg)
Ventilator & Stand (Complete)	54" (137.1 cm)	20 3/4" (52.7 cm)	24" (60.9 cm)	85 lbs. (38.5 kg)

SHIPPING INFORMATION (Dimensions & weight)

	Height	Width	Depth	Weight
Ventilator Only	20" (50.8 cm)	19 1/2" (49.5 cm)	18 1/2" (47 cm)	44 lbs. (20 kg)
Ventilator & Stand (Complete)	40 1/8" (120 cm)	30 1/8" (76.5 cm)	D - 22 7/8" (58 cm)	95 lbs. (43.2 kg)

NOTE

Bird Products Corporation reserves the right to change these specifications without notice.

1.5 ORDERING INFORMATION

The following Part Numbers are for the V.I.P. Bird head only. The head only versions include the Instruction Manual, P/N L1194.

Part No.	Description
15003	120 VAC, 50/60 Hz, English Language
15003S	120 VAC, 50/60 Hz, Spanish Language
15003H	20 VAC, 50/60 Hz, French Language
15003J	100 VAC, 50/60 Hz, Japanese Language
15003C	220 VAC, 50/60 Hz, English Language
15003G	220 VAC, 50/60 Hz, German Language
15003B	220 VAC, 50/60 Hz, French Language
15003L	220 VAC, 50/60 Hz, Spanish Language
15003A	240 VAC, 50/60 Hz, English Language

The following Part Numbers include the following list of accessory items:

- P/N 04820 Ventilator Stand
- P/N 02899 Air Supply Hose
- P/N 00060 Oxygen Supply Hose

Part No.	Description
10210	120 VAC, 50/60 Hz, English Language
10210S	120 VAC, 50/60 Hz, Spanish Language
10210H	120 VAC, 50/60 Hz, French Language
10210J	100 VAC, 50/60 Hz, Japanese Language
10210C	220 VAC, 50/60 Hz, English Language
10210G	220 VAC, 50/60 Hz, German Language
10210B	220 VAC, 50/60 Hz, French Language
10210L	220 VAC, 50/60 Hz, Spanish Language
10210A	240 VAC, 50/60 Hz, English Language

The following Part Number includes the following list of accessory items:

- P/N 04556 Ventilator/Compressor Pedestal Assembly
- P/N 09874 Model 6500 Air Compressor (115 VAC, 60 Hz)
- P/N 02899 Air Supply Hose
- P/N 00060 Oxygen Supply Hose

Part No.	Description
10211	120 VAC, 50/60 Hz, English Language

Optional Accessories:

Part No.	Description
00472	5/8" x 48" IV Pole
03212	Bird Heated Humidifier System w/Power Cord, 115V 50/60 Hz
03292	Wall Mount Bracket
03295	Wall Mount Bracket (CA only)
03296	Universal Humidifier Bracket
03395	IV Pole Bracket
10128	Circuit Support Arm w/Circuit Support Clip (P/N 09343)
04820	Ventilator Stand
06681	5/8" x 33" IV Pole
09220	Flow Meter 0 – 15 lpm
09526	Circuit Support Arm Bracket
10088	Patient Breathing Circuit (Infant) (Reusable/ Autoclavable)
10100	Accessory Transport Package, Basic System (Regulators and Battery/Charger not included)
10106	Pediatric Test Lung
10107	Infant Test Lung
10109*	The PARTNER' Volume Monitor Mounting Bracket

* Needs P/N 10195 (Rail Kit).

Optional Accessories Continued

Part No.	Description
10110	Transport Package, Complete w/Regulators and Battery/ Charger, 115V 50/60 Hz
10134	Patient Breathing Circuit (Pediatric) (Reusable/ Autoclavable)
10139*	V.I.P. BIRD Tray
10174R	Pediatric Flow Sensor (for the PARTNER Volume Monitor
10175R	Infant Flow Sensor
10188	Exhalation Valve Body
10194	Front Panel Protective Cover
10195	Rail Kit (V.I.P. Top Cover)
15050	Hospital Grade Outlet Strip
15060	The PARTNER Volume Monitor
20107D	Exhalation Valve Diaphragm
10175R	Flow Trigger Sensor

* Needs P/N 10195 (Rail Kit).

Section 2.0

Warnings, Cautions & Notes

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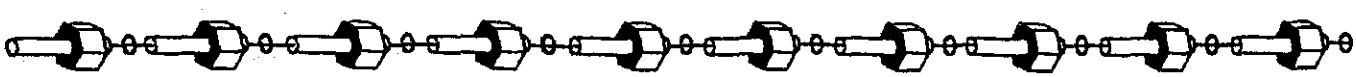
V.I.P. BIRD® Infant-Pediatric Ventilator
Service Manual



V.I.P. SECTION 2: WARNINGS, CAUTIONS & NOTES

The V.I.P. BIRD must be operated by trained, qualified medical personnel under the direct supervision of a licensed physician. Personnel operating the V.I.P. BIRD must become thoroughly familiar with the V.I.P. BIRD Instruction Manual (P/N L1194) prior to using the V.I.P. BIRD with patients. Statements in this manual preceded by the following words are of special significance.

2.1 DEFINITIONS

WARNING ! — **Conditions may exist that could adversely affect the operator or patient.**

CAUTION ✓ — Conditions may exist that could damage the ventilator or other pieces of equipment.

NOTE ✍ — A specific point is made to assist the operator in understanding the equipment.

2.2 WARNINGS

WARNINGS !

- **DO NOT use ventilator in the presence of flammable anesthetics as a possible explosion hazard exists.**
- **To prevent internal damage, always operate the ventilator with clean/ dry medical grade gases. Breathing air used for medical purposes should meet UPS compressed air and/or ANSI Z86.1 – 1973 Grade F and water vapor content should not exceed a dew point 5°F below the lowest anticipated ambient temperature to which the air delivery system is exposed.**
- **Electrical shock hazard; DO NOT remove the ventilator cover. Refer all servicing to a Bird factory trained technician, your Bird distributor or Bird Products Corporation.**
- **Antistatic or electrically conductive hoses or tubing should not be used due to electrical shock hazard.**

SECTION 2: WARNINGS, CAUTIONS & NOTES

WARNINGS !

Continued

- The function of this unit may be adversely affected by the operation of equipment such as high frequency surgical (diathermy) equipment, defibrillators or shortwave therapy equipment in the vicinity.
- For continued protection, replace the fuse or fuses in the power entry module only with one of identical type and rating.
- The ventilator User Verification Tests (UVT) should be run a minimum of once every month or whenever an incident occurs where it is questioned whether the ventilator was operating within the design and performance sspecifications. *(Refer to Section 4.2.3: User Verification Tests.)*
- A ventilator which is not functioning or does not meet manufacturer's design specifications should not be used until all necessary repairs have been made. Contact your Bird distributor or Bird Products Corporation for repair.
- Always use ¼" I.D. tubing for the proximal pressure sensing line. To do otherwise decreases the responsiveness of the system.
- Before patient application, "Pressure Test" the patient circuit including the humidifier module for possible air leakage due to misassembly or damaged components. *(Refer to Section 4.3.2: User Verification Tests.)*
- When the ventilator is connected to a patient, it is recommended that someone be in attendance at all times to take prompt action should an alarm or other indication of a problem occur. An audible alarm indicates an anomalous condition and should never go unheeded.
- Patient circuit disconnects can present a hazard to the patient. Extreme care should be taken to prevent such occurrences by proper adjustments of the alarms and constant attendance of the patient by health care professionals.
- A flashing "OFF" in the Low Peak Pressure alarm display indicates that the alarm limit has not been properly established. Always ensure that the Low Peak Pressure alarm limit is properly established before leaving the patient unattended.
- The operation of each alarm and alert function both audible and visual should be verified daily. Periodically check alarms at clinically suitable instances (e.g. at ventilator checks or when changing the patient circuit) for appropriate adjustment by temporarily disconnecting the patient from the ventilator and verifying that all of the appropriate audible/ visual alarms are in proper operating condition.

WARNINGS !

Continued

- **If the audible alarm or the respective visual indicator of any alarm function should fail to activate during any alarm condition or fail to reset after the alarm has been cleared and the alarm reset key has been depressed, refer the unit to your Bird distributor or Bird Products Corporation.**
- **Consult a physician on the proper fractional concentration of inspired oxygen (FIO_2). Monitor the inspired gas with a calibrated oxygen analyzer and obtain aerial blood analysis and aerial blood gas determinations.**
- **Monitor oxygen concentrations with an accurate oxygen analyzer with high and low (FIO_2) alarms to be assured that the desired FIO_2 is being delivered.**
- **The exhalation valve diaphragm should be checked daily for excessive wear or perforation and replaced when necessary, otherwise improper patient ventilation may occur.**
- **DO NOT place a one-way check valve at the outlet of the exhalation valve as this may adversely affect the function of the ventilator with potential injury to the patient.**
- **Manual breath capability is non-functional during a ventilator inoperative condition.**
- **It is recommended that P/N 10088 or P/N 10134 patient circuit breathing kits, be used with the ventilator. These circuits have been verified acceptable for use with the ventilator and include the 1/8" I.D. proximal pressure sensing line which ensures the responsiveness of the system.**

2.3 CAUTIONS

CAUTIONS ✔

- ✔ As with any other piece of medical equipment, care should be exercised when moving the equipment in the hospital environment to avoid damage.
- ✔ The air inlet filter bowl should be checked before each clinical use and periodically during use. Any condensation in the bowl is a warning signal that condensation may be entering the ventilator.

CAUTIONS ✔

Continued

- ✔ **Do not** sterilize the V.I.P. Bird. The internal components are not compatible with sterilization techniques.
- ✔ Bird Products Corporation bacteria filters are compatible with steam autoclaving "ONLY". **Do not** wash, rinse, soak, pasteurize, ethylene oxide sterilize, or immerse bacteria filters in liquid sterilizing agents as resistance to flow will increase.
- ✔ For ventilator accessories which require sterilization, peak sterilization temperatures should not exceed 130°F (54°C) for gas (ETO) and 250°F (121°C) for steam autoclave to avoid possible damage to elastomeric components. *(Refer to Section 3.4: Cleaning & Sterlization.)*
- ✔ Sterilizing agents which include phenols, dimethyl ammonia chloride, chloride compounds, and greater than 2% gluteraldehyde may cause damage to plastic components. *(Refer to Section 3.4: Cleaning & Sterlization.)*
- ✔ The V.I.P. Bird should be serviced and/or calibrated only by a Bird Products Corporation trained service technician.

2.4 NOTES

NOTES ✍

- Federal law restricts the sale of this device except by or on the order of a physician. The ventilator is a restricted medical device intended for use by qualified personnel under the direction of a qualified physician.
- **Displays Flashing** – When the Tidal Volume, Inspiratory Time, Breath Rate Peak or Flow displays flash it is an indication of an incompatibility. In these cases, the display will flash at a slow rate. The High Pressure Limit display may flash as either an indication of an incompatibility or an alarm condition. If due to an alarm condition, the display will flash at twice the rate that it flashes for an incompatibility. When the Low PEEP/CPAP and Low Peak Pressure alarm displays flash, it is an indication of an alarm condition. In these cases, the display will flash at the higher rate (twice the rate of an incompatibility). The Low Peak Pressure alarm display will flash when set to "OFF" indicating that the alarm limit has not been properly established. In addition, the Pressure Support display will flash whenever the pressure supported breath has been time limited.

NOTES

Continued

- **Tidal Volume Display Flashing (slow rate)** – The operator has attempted to set a Tidal Volume too large for the Peak Flow and Breath Rate settings that have been selected. In response, the ventilator has limited the tidal volume proportionately to the preset Peak Flow and Breath Rate preserving the 250 msec minimum exhalation time, then notifies the clinician of this incompatible setting by flashing the Tidal Volume display. The flashing display indicates the actual tidal volume being delivered.

- **Tidal Volume and Breath Rate Displays Flashing (slow rate)** – The operator has attempted to set a Peak Flow and Breath Rate which are incompatible with a tidal volume of 20 ml. or greater and the 250 msec minimum exhalation time requirement. In response, the ventilator has set the tidal volume to 20 ml. and reduced the breath rate to the maximum which will produce 20 ml. at the preset Peak Flow setting, and notifies the clinician of this incompatible setting by flashing the Tidal Volume and Breath Rate displays. The flashing displays indicate the actual tidal volume and breath rate being delivered. If the tidal volume is preset at 20 ml., only the Breath Rate display will flash.

- **Peak Flow Display Flashing (slow rate):**

  Volume Cycled Mode – The operator has attempted to set a Peak Flow that is too high for the Tidal Volume setting that has been selected and the 150 msec minimum inspiratory time requirement. In response, the ventilator has limited the peak flow to a value that is acceptable for that tidal volume, and notifies the clinician of this incompatible setting by flashing the Peak Flow display. The flashing display indicates the actual peak flow being delivered.

  Time Cycled Mode – The operator has attempted to set a Peak Flow greater than 40 LPM, the maximum flow available in this mode. In response, the ventilator has limited the flow to 40 LPM and notifies the clinician of this fact by flashing the Peak Flow setting. The flashing display indicates the actual peak flow being delivered.

- **Inspiratory Time Display Flashing (slow rate)** – The operator has attempted to set an Inspiratory Time that is too high for the Breath Rate setting that has been selected and the 250 msec minimum exhalation time requirement. In response, the ventilator has limited the inspiratory time to a value that is acceptable for that breath rate, and notifies the clinician of this incompatible setting by flashing the Inspiratory Time display. The flashing display indicates the actual inspiratory time being delivered.

NOTES

Continued

- **High Pressure Limit Display Flashing (slow rate)** – The operator has attempted to set the High Pressure Limit to a value less than the PEEP/CPAP setting plus 3 cmH_2O. In response, the ventilator has limited the high pressure limit to the PEEP/CPAP setting plus 3 cmH_2O, and notifies the clinician of this incompatible setting by flashing the High Pressure Limit display. The flashing display indicates the actual high pressure limit. In addition, the High Pressure Limit Display will flash at the slow rate whenever the operator attempts to set a pressure of greater than 80 cmH_2O in the Time Cycled Mode. The display will limit to 80 cmH_2O and flash that value to indicate the actual setting of the High Pressure Limit.

- **Pressure Support Display Flashing** – This indicates that inspiration during Pressure Support has been time limited rather than flow limited. Inspiration during Pressure Support will be time limited if flow fails to drop to 25% of the peak flow needed to achieve the pressure support level within three seconds or twice the cycle time (whichever is less). The cycle time is determined by the breath rate setting.

- **I:E Ratio Colon Flashing/I:E Ratio LED Flashing** – Indicates that the inspiratory time exceeds the exhalation time, i.e. the I:E Ratio is inversed.

- **Dimmed Displays** – For those controls which are not functional in the current mode of ventilation, the digital display is dimmed. The numbers in the dimmed display represent the current control setting or the limited value in the case of incompatible settings. In the event the value is limited, the display will flash when the mode is changed to one where the control is functional.

- The High Pressure Limit alarm should always be set below the Over-Pressure Relief valve setting to allow the High Pressure Limit alarm to activate.

- Bird breathing circuit water traps (P/N 09413) have been incorporated into the inspiratory and expiratory limbs of the circuit to collect condensation from the humidified gas.

- Adjustment of the Assist Sensitivity control in the Volume Cycled mode establishes the trigger level for all breath types. Particular attention should be given to the adjustment of this control.

- To minimize the effect on tidal volume, sensitivity, and baseline maintenance, the lowest flow which gives effective nebulization should be used. It is recommended that flow not exceed 15 LPM.

NOTES ✍

Continued

- Pressing the Alarm Reset push button at any time, except during the Control Tests, will discontinue UVT and normal ventilation will begin.
- If the "ILLEGAL" message appears, the language setting will default to English. At the first available opportunity, the Language Select switch should be checked by a service technician.
- If the "ILLEGAL" message appears, the Apnea Interval setting will default to 20 seconds. At the first available opportunity, the Apnea Interval switch should be checked by a service technician.
- If the Mode control is placed in between legal positions, the message "SET MODE" will appear.

Section 3.0

Operating Instructions

3.1 Description of Controls, Monitors, Indicators and Alarms 3-1
3.2 Assembly Instructions 3-19
3.3 Overview of the System Operation 3-25
3.4 Cleaning and Sterilization 3-38
3.5 Troubleshooting Guide 3-40

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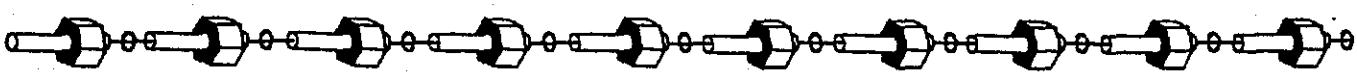
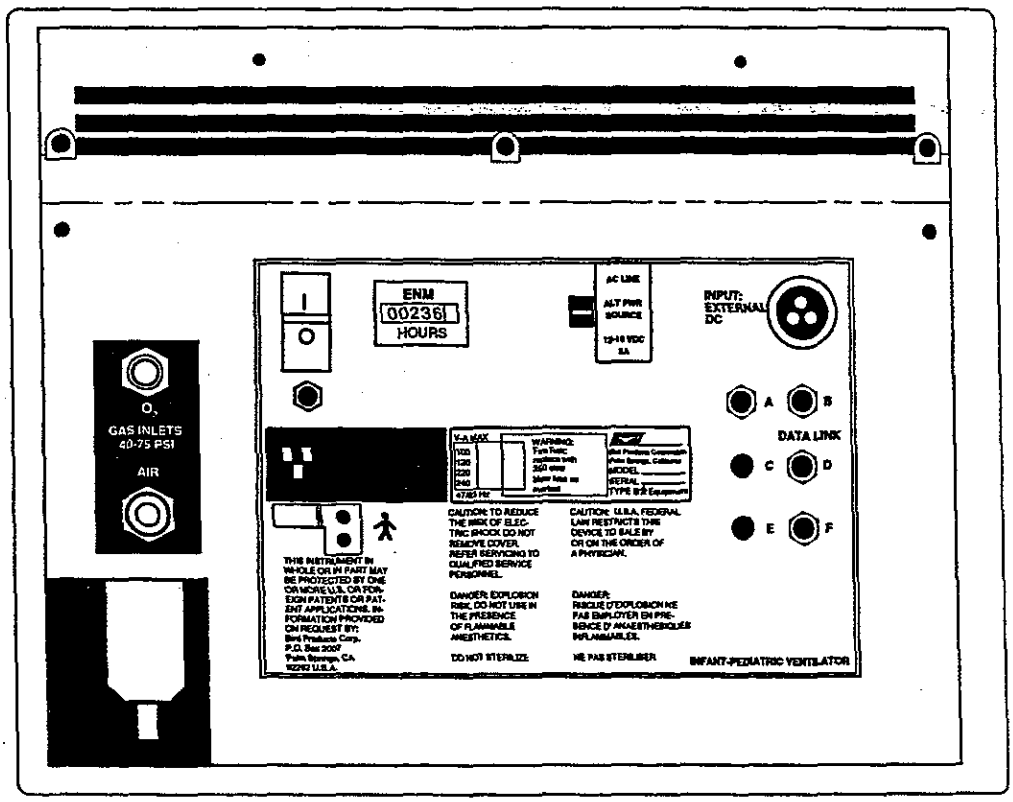


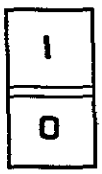
V.I.P. SECTION 3.0: OPERATING INSTRUCTIONS

3.1 DESCRIPTION OF CONTROLS, MONITORS, INDICATORS, AND ALARMS

❒ Back Panel Descriptions

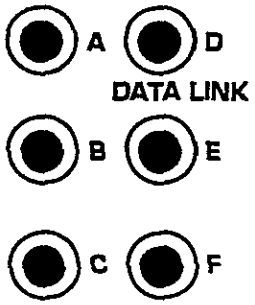
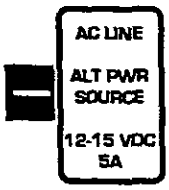
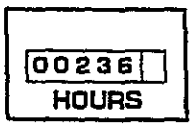
Figure 3.1.1
Back Panel View



	*ON/OFF SWITCH CIRCUIT BREAKER:* Turns power to the ventilator **ON** or **OFF (O/I)**. There is a green Power Indicator on the front control panel. This switch also incorporates a circuit breaker which monitors the internal low voltage power supply.
	POWER ENTRY MODULE (Line Voltage Select): Located on the rear of the ventilator, the power entry module accepts the power cord and encloses the fuse package for over-current protection. A single 1-1/4 inch fuse or two 5 x 20 mm fuses can be accommodated. The module also contains a switch that can set for the appropriate line voltage (i.e., 100, 120, 220, or 240 VAC).

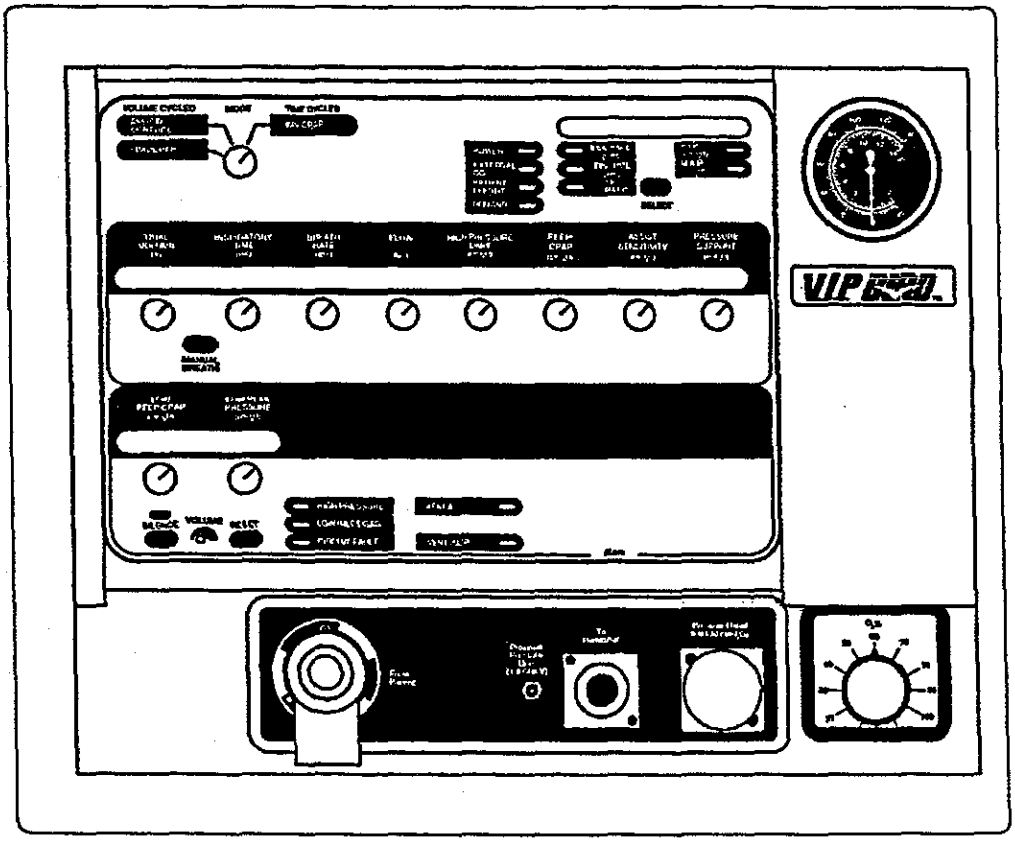
SECTION 3.0: OPERATING INSTRUCTIONS

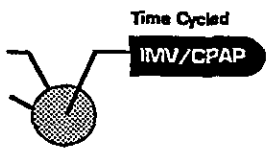
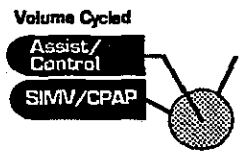
Back Panel Descriptions Continued

	*DATA LINK (Input):* Provides input connection for a high speed fiber optic data link. This input will be used to input ventilation data for future respiratory monitoring equipment. *DATA LINK (Output):* Provides connection for high speed fiber optic data link. This output will be used to transport ventilation data to a Bird Interface Module – RS232, PARTNER™ Volume Monitor, the Bird Graphics Monitor and/or other respiratory monitoring equipment.
	*AC/DC SWITCH:* Switches power source from AC Line Voltage to 12 VDC alternate external power supply.
	*HOURMETER:* The elapsed hourmeter records the total hours of ventilator operation. It is activated when ever the ventilator is AC line or 12 VDC external power supply operated. The hourmeter is nonresettable and records to the whole hour. The elapsed hourmeter allows the clinician to determine the actual usage hours as well as for establishing routine maintenance schedules.
	DC INPUT RECEPTACLE: Allows for the attachment of an external 12 VDC 5 amp power supply for emergency of transport application.
	AIR AND OXYGEN INLETS: Provides input for 40 to 75 PSIG (2.8 to 5.2 kg/cm2) AIR and OXYGEN. Air and OXYGEN differential pressure must not exceed 20 PSIG (1.4 kg/cm2) for proper function of the blender.

❒ Front Panel Descriptions

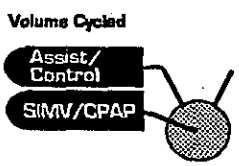
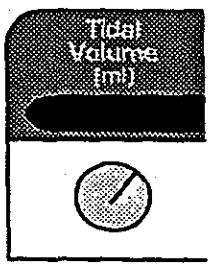
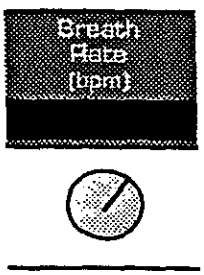
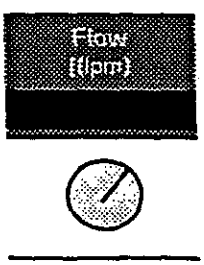
Figure 3.1.2
Front Panel View



	*MODE CONTROL (Time Cycled) IMV/CPAP:* The ventilator will deliver time cycled pressure limited mandatory breaths (controled) at a prescribed Inspiratory Time, Breath Rate, O_2%, Flow, High Pressure Limit, and PEEP. If the Breath Rate is set to zero, the mode is CPAP.
	*MODE CONTROL (Volume Cycled) :* *ASSIST/CONTROL:* A volume controlled mandatory breath is delivered with each inspiratory effort, which meets the preset Assist Sensitivity criteria. If the patient does not trigger, the ventilator automatically delivers breaths according to the Breath Rate control setting. Therefore, mandatory breath may be patient initiated (assisted) or ventilator initiated (controlled).

SECTION 3.0: OPERATING INSTRUCTIONS

Front Panel Control Descriptions Continued

	*MODE CONTROL (Volume Cycled) :* *MODE CONTROL(SIMV/CPAP):* Allows the patient to breathe spontaneously from the ventilator's demand system and receive a fixed number of mandatory breaths as set on the Breath Rate control. The mandatory breaths may be patient initiated or ventilator initiated and will be synchronized with the patient's breathing pattern if the Assisted Sensitivity is properly set. If the Breath Rate control is set to zero, the mode is CPAP.
	*TIDAL VOLUME CONTROL:* Sets the volume of gas delivered for Controlled and Assisted breaths in the Volume Cycled modes (i.e., Assist/Control and SIMV/CPAP). Inspiration terminates when the tidal volume has been delivered. Range: 20 to 995 ml.
	INSPIRATORY TIME CONTROL: Sets the length of the inspiratory time period for mandatory breath in the Time Cycled mode (i.e., IMV/CPAP). Range: 0.10 to 3.00 sec.
	*BREATH RATE CONTROL:* Sets the number of mandatory breaths delivered in IMV/CPAP and SIMV/CPAP, and in the minimum number in the Assist/Control mode. Range: 0 to 150 BPM.
	*FLOW CONTROL:* In the Volume Cycled modes (Assist/Control, SIMV/CPAP), sets the maximum flow delivered during inspiratory phase of Controlled, Assisted, and Manual breaths. This control has no effect on the flow available during spontaneous and Pressure Supported breaths. The maximum flow available for spontaneous and Pressure Supported breaths is 120 LPM.

FLOW CONTROL (Continued): In the Time Cycled mode (IMV/CPAP), the flow control sets the flow delivered during the inspiratory phase of Controlled breaths, and the baseline to which flow returns during expiratory phase, i.e., the continuous flow available for spontaneous breathing.

NOTE: The maximum baseline (continuous) flow is 15 LPM. This control has no effect on the demand flow available to augment the continuous flow during spontaneous breaths. The demand system can augment the continuous flow up to 120 LPM.

EXAMPLES:
➧ If Peak Flow Setting = 6 LPM, then ➥ Inspiratory Flow = 6 LPM and ➥ Baseline Flow = 6 LPM
➧ If Peak Flow Setting = 10 LPM, then ➥ Inspiratory Flow = 10 LPM and ➥ Baseline Flow = 10 LPM
➧ If Peak Flow Setting = 15 LPM, then ➥ Inspiratory Flow = 15 LPM and ➥ Baseline Flow = 15 LPM
➧ If Peak Flow Setting = 25 LPM, then ➥ Inspiratory Flow = 25 LPM and ➥ Baseline Flow = 15 LPM

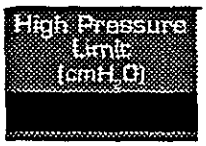
RANGE: Time Cycled Mode;

- 3 to 40 LPM (inspiratory)
- 3 to 15 LPM (expiratory)

Volume Cycled Modes:

- 3 to 100 LPM

Front Panel Control Descriptions Continued



HIGH PRESSURE LIMIT CONTROL: This is a control parameter in the Time Cycled mode (i.e., IMV/CPAP) and establishes the peak inspiratory pressure for the mandatory breaths. Once the limit is reached, the exhalation valve opens and "servos" to this pressure until the inspiratory time is complete.

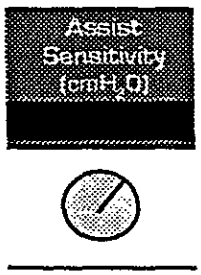
This is a alarm parameter in the Volume Cycled modes (i.e., Assist/Control and SIMV/CPAP) inspiratory pressure for the mandatory breaths. Once the proximal pressure exceeds the alarm setting, or the machine outlet pressure exceeds the alarm setting + 30 cmH_2O, the audible/visual indicators will activate.

Flow delivery will stop, and the ventilator will be forced into the exhalation phase. If the pressure does not reset below PEEP + 3 cmH_2O within 3 seconds (8 seconds for machine outlet pressure), the safety and exhalation valves will be opened to allow the patient to breathe room air. If the expiratory leg is occluded, pressure will vent back through the safety valve via a small bypass hole in the check valve. If pressure resets below PEEP + 3 cmH_2O, the safety valve will close and the ventilator will resume normal operation. The audible alarm will continue until the safety valve has closed. The visual indicator will continue to flash until the reset button is depressed.

Range:
- 3 to 120 cmH_2O (Volume Cycled mode)
- 3 to 80 cmH_2O (Time Cycled mode)

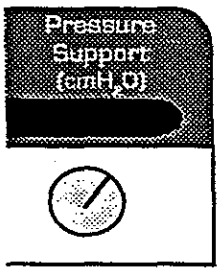
PEEP/CPAP CONTROL: Establishes the pressure in the patient circuit between the end of inspiration and the start of the next inspiration. Also known as baseline pressure.

Range: 0 to 24 cmH_2O



ASSIST SENSITIVITY CONTROL: Sets the trigger level below baseline pressure for the initiation of assisted and spontaneous breaths in the Volume Cycled modes (i.e. Assist/Control, SIMV/CPAP). In the IMV/CPAP mode, demand sensitivity is preset at 1.0 cmH_2O and is unaffected by the Assist/Sensitivity control.

Range: 1 to 20 cmH_2O, OFF



PRESSURE SUPPORT CONTROL: Available in the SIMV/CPAP mode, sets the inspiratory pressure above PEEP/CPAP which is achieved during spontaneous breaths. Pressure supported breaths are terminated when decreases to 25% of the peak flow needed to achieve the peak pressure. If a leak in the patient circuit prevents flow from decreasing to 25%, the breath will be terminated after 3 seconds or two breath periods, whichever comes first. After 1.5 liters have been delivered, flow will be decreased to 40 LPM for the remainder of the 3 second inspiratory time. If the breath is time limited, as opposed to flow limited, the Pressure Support display will flash.

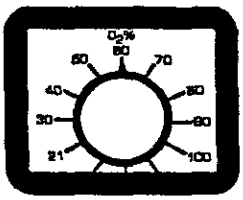
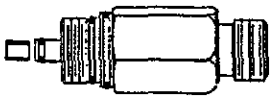
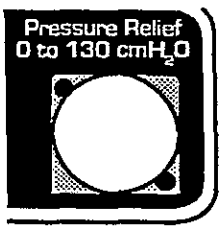
Range: OFF, 1 to 50 cmH_2O
SEE BULLETINS

MANUAL BREATH BUTTON CONTROL: Used to deliver a single, operator initiated controlled breath. Volume is determined by the Tidal Volume setting in the Volume Cycled modes and the Inspiratory Time, Peak Flow, and High Pressure Limit settings in the Time Cycled mode. Manual breaths are available in all modes, however, Manual Breaths requests, which occur during the inspiratory or minimum exhalation time phase of all breath types are ignored.

NOTE: Manual breath is non-functional during a Ventilator Inoperative condition.

SECTION 3.0: OPERATING INSTRUCTIONS

Front Panel Control Descriptions Continued

	*OXYGEN PERCENT CONTROL:* Adjusts the FI02 of the gas delivered to the ventilator. The ventilator must be connected to 40 to 75 PSIG (2.8 to 5.2 kg/cm2) oxygen and air, and the gas supplies must be within 10 PSIG (1.4 kg/cm2) for accurate blending. Range: 21 to 100% ± 3%
	*BLENDER AUXILIARY OUTLET:* Located on the right hand side of the ventilator, adjacent to the oxygen percent control. This outlet can accept a 0 to 15 LPM flowmeter. This flow of blended gas can be used to power a in-line nebulizer or a hand-held resuscitator. Range: 0 to 15 LPM
	*OVER-PRESSURE RELIEF CONTROL:* This is a variable mechanical relief valve, located at the lower right hand side of the ventilator between the machine outlet and the oxygen percent control. This sets the maximum allowable pressure in the patient circuit. The valve opens at a preset pressure, however, due to resistance in the inspiratory leg of the patient circuit, the proximal pressure may be lower. In the Time Cycled mode, the Over-Pressure Relief Valve should be set greater than 15 cmH_2O above the High Pressure Limit control setting. In the Volume Cycled modes, the Over-Pressure Relief Valve should be set greater than 5 cmH_2O above the High Pressure Limit alarm setting. Range: 0 to 130 cmH_2O ± 10 cmH_2O
	SELECT BUTTON: Depression of this button once activates a scan function, whereby each monitored value is scanned in sequence and displayed for four seconds. An "S" will appear in the display window to indicate that the scan function has been activated and an amber LED is illuminated next to the monitored value currently displayed.

	SELECT BUTTON (Continued): Depression of this button during the scan function will hold the display to the currently selected monitored parameter. The "S" will disappear from the display window and the displayed value will continue to update according to its protocol. Additionally, if the Select Button is held down for two seconds, the user selected apnea interval will be displayed.
P.I.P. (cmH_2O)	*PEAK INSPIRATORY PRESSURE MONITOR:* Displays the peak inspiratory pressure for the previous breath as monitored via the proximal airway pressure sensing line. Applies to all breath types except spontaneous without pressure support. Range: 0 to 120 cmH_2O
M.A.P. (cmH_2O)	*MEAN AIRWAY PRESSURE MONITOR:* Displays the average proximal airway pressure based on a 40 second moving average. The Mean Airway Pressure display is updated every eight (8) seconds. The value applies to all breath types. Range: 0 to 80 cmH_2O
Breath Rate (bpm)	*BREATH RATE MONITOR:* Displays the average total number of breaths per minute. Applies to all breath types detected by the ventilator. In IMV/CPAP only mandatory breaths are counted. Range: 0 to 250 BPM
Insp Time (sec)	*INSPIRATORY TIME MONITOR:* Displays the inspiratory time as defined by the Breath Rate and Inspiratory Time controls for the IMV/CPAP mode. For Assisted/Control and SIMV/CPAP displays the inspiratory time as defined by the Breath Rate, Tidal Volume, and Peak Flow controls. This monitor does not apply to patient initiated breaths and the I:E Ratio display exhibits dashes (- - - -) when the Breath Rate control is set to zero. Range: 0.05 to 60 seconds

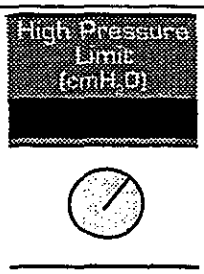
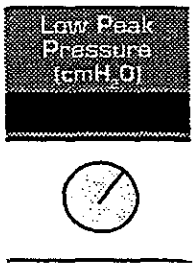
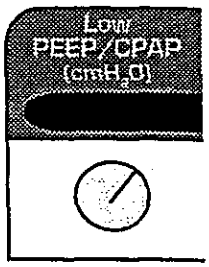
Front Panel Control Descriptions Continued

I:E Ratio	**I:E RATIO MONITOR:** Displays the Inspiratory Time to Exhalation Time as a ratio with Inspiratory Time normalized to one. This monitor does not apply to patient initiated breaths (refer to Inspiratory Time Monitor in this section). I:E = 1: (Exh. Time/Insp. Time) When the I:E Ratio is less than 1:1 (i.e., 1:0.9, 1:0.8, etc.), the display flashes (:) to indicate an inverse condition. Range: 1:0.1 to 1:60

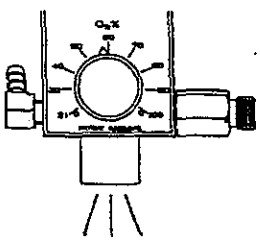
❒ Front Panel Indicator Descriptions

Patient Effort	*PATIENT EFFORT INDICATOR:* Indicates that a patient inspiratory effort which exceeds the Assist Sensitivity setting has been detected. Indicates Assisted, Pressure Supported, and Spontaneous breath types in Assist/Control and SIMV/CPAP.
Demand	**DEMAND INDICATOR:** Operational in the IMV/CPAP only. Indicates when the demand system has been triggered by a spontaneous breath. The demand system augments continuous flow and is triggered at -1.0 cmH_2O. This indicator will remain lit as long as the demand system is active.
Power	*POWER INDICATOR:* Indicates that AC or DC power is present and the Power Switch is **ON**.
External DC	*EXTERNAL DC INDICATOR:* Indicates that the ventilator is operating from external DC power.

❒ Front Panel Alarm Descriptions

	*HIGH PRESSURE LIMIT ALARM:* This High Pressure Limit control is an alarm parameter in the Volume Cycled modes. See High Pressure Limit control for description of alarm function in volume cycled modes. Range: 3 to 120 cmH_2O
	*LOW PEAK PRESSURE ALARM:* The Low Peak Pressure Alarm is activated if the proximal pressure fails to exceed the alarm setting during the inspiratory phase of a breath. This alarm is active for all breath types except Spontaneous and Pressure Supported. If the alarm is set to the OFF position, the display will flash continuously as a reminder that the alarm limit has not been properly established. Range: OFF, 3 to 120 cmH_2O
	*LOW PEEP/CPAP ALARM:* The Low PEEP/CPAP Alarm is activated if the proximal pressure drops below the alarm setting for longer than 0.5 seconds at any time during the ventilation cycle. Range: -9 to 24 cmH_2O
	HIGH/PROLONGED PRESSURE ALARM: In the IMV/CPAP mode (i.e., Time Cycled), this alarm activates if the proximal pressure exceeds the High Peak Pressure Limit setting plus 10 cmH_2O. Once the alarm activates, the ventilator is forced into the exhalation phase. If the pressure does not reset below PEEP +3 cmH_2O within 3 seconds, the safety and exhalation valves will be opened to allow the patient to breathe spontaneously from room air. If the expiratory leg is occluded, pressure will vent back through the safety valve via a small bypass hole in the check valve. If pressure resets below PEEP +3 cmH_2O within 3 seconds , the safety valve will close and the ventilator will resume normal operation. The audible alarm will be on until the pressure has reset and/or the safety valve has closed. The visual indicator will remain illuminated until the reset button is depressed.

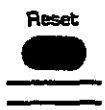
Front Panel Alarm Descriptions Continued

High Pressure	*HIGH/PROLONGED PRESSURE ALARM (Continued):* In all modes of ventilation, this alarm will activate if the proximal pressure exceeds PEEP +6 cmH_2O for a continuous period of 250 milliseconds commencing 500 milliseconds after the start of the exhalation phase. This is an alarm function only and no action is taken by the ventilator.
Apnea	*APNEA ALARM:* This alarm activates when the interval between detected inspirations exceeds the alarm setting. This alarm is not active in IMV/CPAP or any time continuous flow is present. The Apnea Interval Select switch is internal to the ventilator. Range: 20, 40, 60 seconds
Low Inlet Gas	*LOW INLET GAS PRESSURE ALARM:* This alarm activates whenever the system pressure falls below 22.5 PSIG or rises above 27.5 PSIG. The audible alarm will activate and the visual indicator will be lit. This alarm can be caused by a dirty inlet filter, blender malfunction, or regulator malfunction. If the pressure continues to drop to <20 PSIG or continues to rise to >30 PSIG for greater than 1 second, the result will be a ventilator inoperative condition.
	*BLENDER INPUT GAS ALARM (Audible only):* This alarm activates whenever the pressure differential between the input air pressure and input oxygen pressure exceeds 20 PSIG. The alarm is characterized by a high pitched pneumatic whistle and has no visual indication. During the alarm condition, the higher of the two pressures is "bypassed" through to the ventilator (i.e. either 21% or 100% oxygen).

Vent Inop	*VENTILATOR INOPERATIVE ALARM:* This alarm condition causes the ventilator to cease normal operation, i.e., close the flow control valve, open the safety and exhalation valves, and closes all the solenoids, thereby allowing the patient to breathe from room air. Ventilator inoperative conditions are divided into two groups: recoverable and non-recoverable. Recoverable conditions include: loss of power supply voltage and system pressure less than 20 PSIG (1.4 kg/cm2) or greater than 30 PSIG (2.1 kg/cm2) for longer than 1 second. When the condition no longer exists, the ventilator will run the Power On Self Test and then resume normal operation. Non-recoverable conditions are created by software detection of an out of tolerance condition. See description of Power On Self Test (POST) and continuous System Verification (CST). Non-recoverable conditions require that the power switch be turned off and back on to reset the ventilator.
Circuit Fault	*CIRCUIT FAULT ALARM :* The purpose of this alarm is to detect a possible patient circuit or pressure transducer fault and alert the clinician to the condition. the alarm is activated when any of the following occur: • While in the inspiratory phase, 40 milliseconds after the start of inspiration, a proximal and machine outlet pressure comparison test begins. If the machine pressure is more than 30 cmH_2O above or 8 cmH_2O below the proximal pressure for longer than 20 milliseconds, the alarm will activate. • While in the inspiratory phase, 40 milliseconds after the start of inspiration, A proximal and exhalation pressure comparison test begins. If the absolute difference between the proximal and exhalation transducer readings is more than 8 cmH_2O for longer than 20 milliseconds, the alarm will activate.

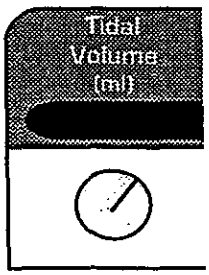
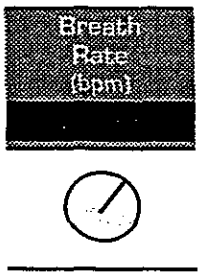
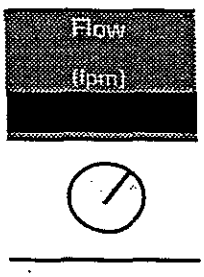
Front Panel Alarm Descriptions Continued

Circuit Fault	*CIRCUIT FAULT ALARM (Continued):* • While in the exhalation phase, 200 milliseconds after the start of the exhalation, a proximal and machine pressure comparison test begins. If absolute difference between the proximal and machine transducer readings is more than 8 cmH_2O for longer than 20 milliseconds, the alarm will activate. • While in the exhalation phase, 200 milliseconds after the start of the exhalation, a proximal and exhalation pressure comparison test begins. If the proximal pressure is more than 18 cmH_2O above or 8 cmH_2O below the exhalation pressure for longer than 20 milliseconds, the alarm will activate. Once activated, the ventilator is immediately forced into the exhalation phase with the higher of the two pressures fed to the exhalation servo for purposes of PEEP control. If the mismatch condition continues for greater than 8 seconds, the flow control valve will close, the safety and exhalation valves will be opened to allow the patient to breathe spontaneously from room air. When the mismatch condition no longer exists the proximal and exhalation pressure transducers drop below PEEP + 3 cmH_2O and the machine pressure transducer drops below PEEP + 5 cmH_2O the ventilator will resume normal operation. This alarm is active during all ventilation except during the inspiratory phase of a Pressure Support breath.
	UNKNOWN MODE SETTING ALARM: This alarm occurs whenever the Mode Select switch is left between legal mode settings for a period of time exceeding two seconds. The audible alarm will sound and the message "SET MODE" will be displayed on the front panel monitor window, informing the user to set the mode switch to a legal position. The ventilator continues to operate using the most recent legal mode setting.

	UNKNOWN MODE SETTING ALARM (Continued): If the Mode Select switch is between legal settings during power-up, the ventilator enters a non-recoverable ventilator inoperative condition and displays the message "17 MODE" on the monitor window. The power switch should be set to OFF, the Mode Selector switch set to a legal setting, and the power set to ON again.
	ALARM SILENCE: Allows the clinician to temporarily disable the audible portion of all alarms, except the Ventilator Inoperative alarm, for 60 seconds. Activating the control again within the 60 second silence period will restore the audible alarm. When the Power switch is switched to the OFF position, the Ventilator Inoperative alarm which occurs can be permanently silenced. If loss of power occurs with the Power switch in the ON position, the Ventilator Inoperative alarm which occurs can not be silenced until the Power switch is moved to the OFF position, or the Super cap discharges, whichever comes first.
	*ALARM RESET:* Resets the visual and audible alarm indication which no longer exists.
	ALARM VOLUME: Sets the intensity of the audible alarm at one (1) meter. Range: 70 to 85 dB
	ILLEGAL APNEA INTERVAL SWITCH SETTING ALARM: This alarm is visual only. Should the Apnea switch be set to an illegal state, the ventilator will notify the user by displaying a message on the front panel monitor display window ("ILLEGAL APNEA DEFAULT 20"). This message will be displayed until the Monitor Display Select switch is pressed, or the Apnea switch setting is changed. This message appears only once during any power-up period. Should an Illegal Apnea Setting be detected, the ventilator will default to an Apnea interval of 20 seconds.

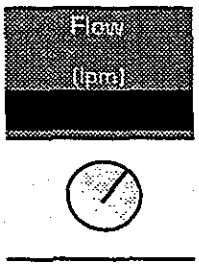
Front Panel Alarm Descriptions Continued

	ILLEGAL LANGUAGE SELECT SWITCH SETTING ALARM: This alarm is visual only. Should the Language Select switch be set to an illegal state, the ventilator will notify the user by displaying a message on the front panel monitor display window ("ILLEGAL LANGUAGE DEFAULT ENGLISH"). The message will be displayed until the Monitor Display Select switch is pressed, or the Language Select switch is changed. This message appears only once during any power-up period. Should an Illegal Language Setting be detected, the ventilator will default to English.
	CPU/SOFTWARE ERROR ALARM: This alarm is visual only. While detection of these errors does not require that the ventilator be immediately put into an inoperative condition, the ventilator should be taken out of operation as soon as possible and referred to a Bird Trained Service Technician.
	INCOMPATIBILITY ALARM: This alarm is visual only. Display Flashing - When the Tidal Volume, Inspiratory Time, Breath Rate, and Flow displays flash it is an indication of an incompatibility. In these cases, the display will flash at a slow rate. The High Pressure Limit control may flash as either an indication of an incompatibility or an alarm condition. If due to an alarm condition , the display will flash at twice the rate that it flashes for an incompatibility and be accompanied by an audible alarm. When the Low PEEP/CPAP and Low Peak Pressure displays flash it is an indication of an alarm condition. In these cases, the display will flash at the higher rate (twice the rate of an incompatibility) and be accompanied by an audible alarm.

	*TIDAL VOLUME ALARM:* This alarm is visual only. • **Tidal Volume Display Flashing (slow rate)** – The operator has attempted to set a Tidal Volume too large for the Peak Flow and Breath Rate settings that have been selected. In response, the ventilator has limited the tidal volume proportionately to the preset Peak Flow and Breath Rate preserving the 250 msec minimum exhalation time, then notifies the clinician of this incompatible setting by flashing the Tidal Volume display. The flashing display indicates the actual tidal volume being delivered.
	*TIDAL VOLUME/BREATH RATE ALARM:* This alarm is visual only. • **Tidal Volume and Breath Rate Displays Flashing (slow rate)** – The operator has attempted to set a Peak Flow and Breath Rate which are incompatible with tidal volume of 20 ml. or greater and the 250 milliseconds minimum exhalation time requirement. In response, the ventilator has set the tidal volume to 20 ml. at the preset Peak Flow setting, and notifies the operator of this incompatible setting by flashing the Tidal Volume and Breath Rate indicators. The flashing displays indicate the actual tidal volume and breath rate being delivered. If the Tidal Volume is preset at 20 ml., only the Breath Rate display will flash.
	*PEAK FLOW ALARM:* This alarm is visual only. Peak Flow Display Flashing (slow rate): • **Volume Cycled Mode** – The operator has attempted to set a Peak Flow that is too high for the Tidal Volume setting that has been selected and the 150 msec minimum inspiratory time requirement. In response, the ventilator has limited the peak flow to a value that is acceptable for that tidal volume, and notifies the clinician of this incompatible setting by flashing the Peak Flow display. The flashing display indicates the actual peak flow being delivered.

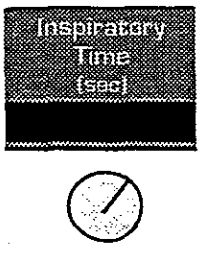
SECTION 3.0: OPERATING INSTRUCTIONS

Front Panel Alarm Descriptions Continued



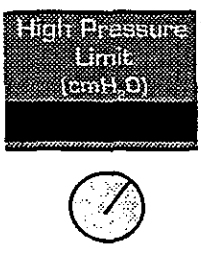
PEAK FLOW ALARM (Continued):

- **Time Cycled Mode** – The operator has attempted to set a Peak Flow greater than 40 LPM, the maximum flow available in this mode. In response, the ventilator has limited the flow o 40 LPM and notifies the clinician of this fact by flashing the Peak Flow setting. The flashing display indicates the actual peak flow being delivered.



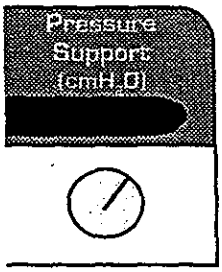
INSPIRATORY TIME ALARM: This alarm is visual only.

- **Inspiratory Time Display Flashing (slow rate)** – The operator has attempted to set an Inspiratory Time that is too high for the Breath Rate setting that has been selected and the 250 millisecond minimum exhalation time requirement. In response, the ventilator has limited the inspiratory time to a value that is acceptable for that breath rate, and notifies the operator of this incompatible setting by flashing the Inspiratory Time indicator. The flashing display indicates the actual inspiratory time being delivered.



HIGH PRESSURE LIMIT ALARM: This alarm is visual only.

- **High Pressure Limit Display Flashing (slow rate)** – The operator has attempted to set the High Pressure Limit to a value less than the PEEP/CPAP setting plus 3 cmH_2O that has been selected. In response, the ventilator has limited the high pressure limit to the PEEP/CPAP setting plus 3 cmH_2O, and notifies the operator of this incompatible setting by flashing the High Pressure Limit indicator. The flashing display indicates the actual high pressure limit.



PRESSURE SUPPORT ALARM: This alarm is visual only.

- **Pressure Support Display Flashing (slow rate)** - If a leak in the patient circuit prevents the flow from dropping to 25% of the peak flow needed to achieve the peak pressure, the breath will be time limited as opposed to flow limited. The Pressure Support display will flash indicating that the breath is time limited.

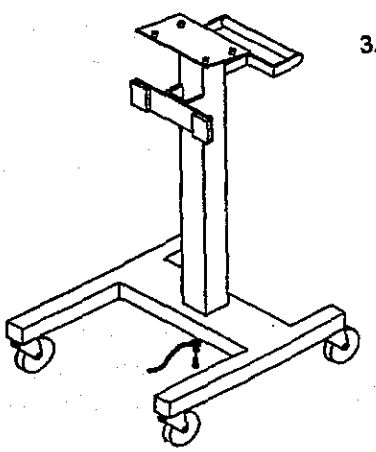
DIMMED DISPLAY ALARM: **This alarm is visual only.**

- **Dimmed Displays** – For those controls which are not functional in the current mode of ventilation, the digital display is dimmed. The numbers in the dimmed display represent the current control setting or the limited value in the case of incompatible settings. In the event the value is limited, the display will flash when the mode is changed to one where the control is functional.

3.2 ASSEMBLY INSTRUCTIONS

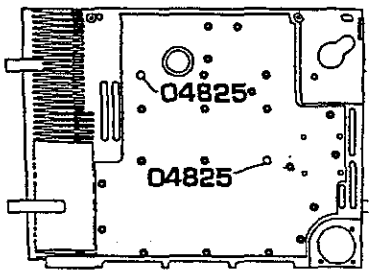
NOTE ✍

Prior to setting up the V.I.P. Bird Ventilator, the operator must *first read and understand* Section 2: "Warnings, Cautions, and Notes."

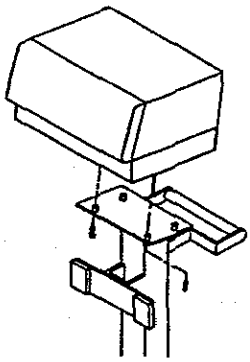


3.2.1. Assemble stand as directed on page B-1 in the Addenda Section. Then go to step 3.2.2 on page 3-20.

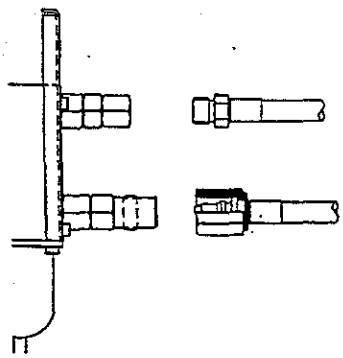
SECTION 3.0: OPERATING INSTRUCTIONS



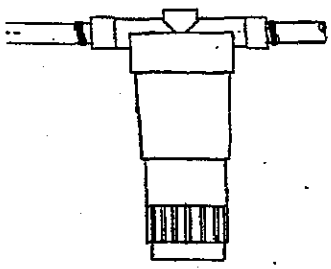
3.2.2 Place ventilator on its top, then install the two alignment pins P/N 04825 as shown. Finger tighten to secure.



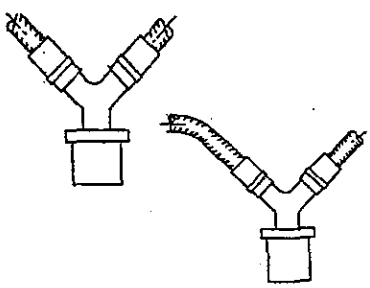
3.2.3 Place the ventilator onto the transport stand P/N 04820 and secure with the two screws P/N 40001 provided. Tighten screws firmly using a $^{3}/_{16}$" Allen wrench.



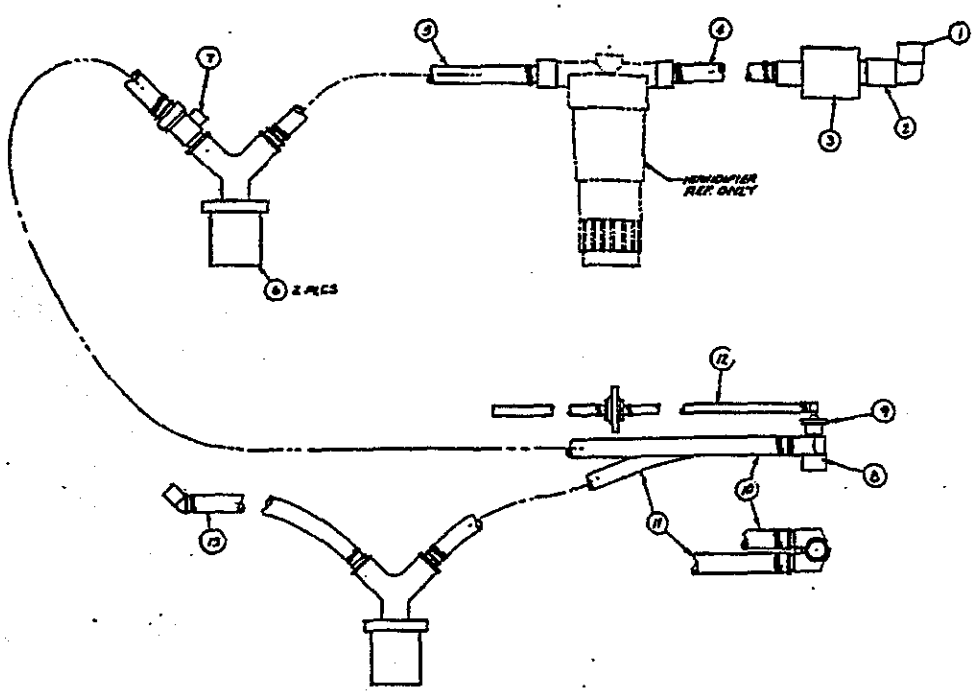
3.2.4 Connect the oxygen hose P/N 00060 and air hose P/N 02899 to the DISS fittings on the rear of the ventilator



3.2.5 Attach the heated humidifier of choice to the dovetail bracket provided on the transport stand P/N 04820. If the humidifier of choice requires a pole mount bracket, use the optional universal humidifier bracket P/N 03296.

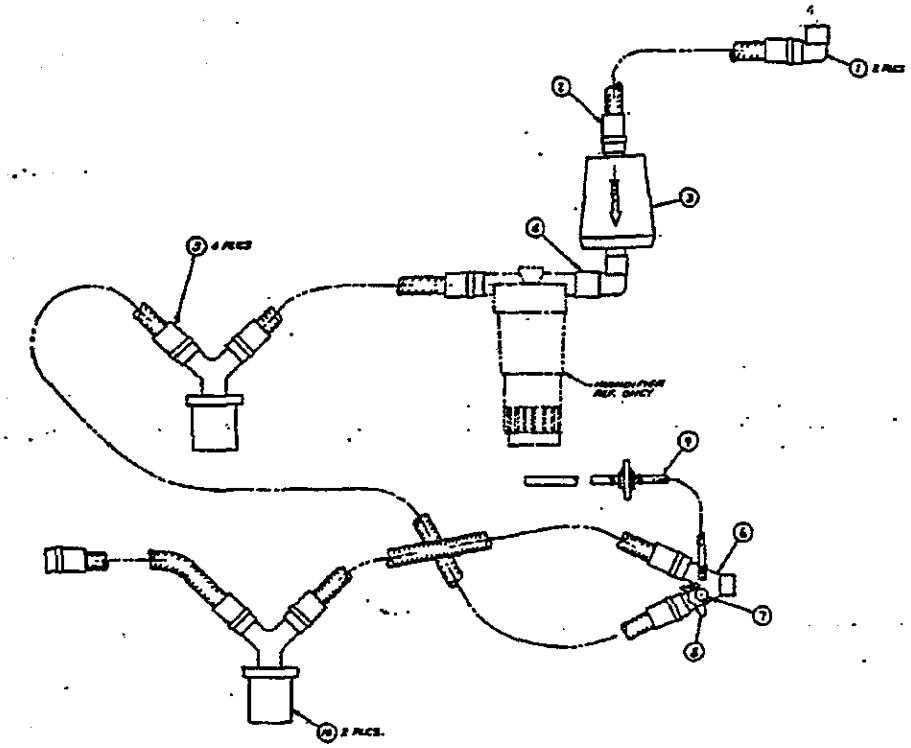


3.2.6 Bird breathing circuit water traps P/N 09413 have been incorporated into the inspiratory and expiratory limbs of the circuit to collect condensation from the humidified gas. Install the exhalation valve diaphram P/N 20107 and connect the exhalation valve body P/N 10087 to the exhalation valve on the ventilator.



3.2.7 Assemble the infant patient circuit P/N 10088 as shown. Connect the 90° elbow adaptor ((#1) P/N 04709 to the ventilator outlet labeled to humidifier. Connect the straight adaptor (#2) P/N 00423 between the 90° elbow adaptor and the infant main flow bacteria filter (#3) P/N 33533. Attach the tube (#4) P/N 10135 between the bacteria filter and the humidifier. Attach the remaining leg of the inspiratory patient circuit to the outlet of the humidifier, (#5) P/N 10136, (#6) P/N 09413, (#7) P/N 03036, (#8) P/N 01224, and (#10) P/N 08295 Attach the expiratory leg of the infant patient circuit to the exhalation valve body inlet port P/N 10087, (#11) P/N 08296, (#6) P/N 09413, (#13) P/N 08297.

3.2.8 Attach the end of the 1/8"I.D. proximal airway tube which includes the bacteria filter (#12) P/N 09537 to the barbed nipple on the front of the ventilator labeled, (PROXIMAL PRESSURE LINE 1/8" ONLY) Make certain that the other end is securely attached to the appropriate port on the patient wye, (#9) P/N 07701. **If a servo- controlled heated humidifier is being used:** Insert the temperature probe securely into the remote temperature sensor adaptor (#7) P/N 03036 on the inspiratory leg of the infant patient circuit. **(If a temperature probe is not being used, remove the remote sensor adaptor from the circuit and install the temperature port plug.)**



3.2.9 For the pediatric patient circuit, P/N 10134 connect the 90° elbow adapter (#1) P/N 04709 to the ventilator outlet labeled "TO HUMIDIFIER " with the male portion of the adapter directed down. Attach one end of the 18 inch circuit tubing (#2) P/N 33545 to the 90° elbow adapter and the other end to the main flow bacteria filter (#3) P/N 09534.

NOTE

FLOW DIRECTION ARROW OF BACTERIA FILTER IS TO THE HUMIDIFIER)

Connect the female portion of the second 90° elbow adapter (#1) P/N 04709 to the other end of the main flow bacteria filter, then connect the 22mm I.D. Cuff adapter (#4) P/N 00423 to the male portion of the 90° elbow adapter. Attach the entire assembly to the inlet of the heated humidifier chamber.

WARNING !

Before patient application, "PRESSURE TEST" the patient circuit including the humidifier heater module for possible gas leak due to misassembly or damaged components.

3.2.10 Pressure Test

3.2.10.1 Attach the oxygen and air 50 PSIG gas source to inlets on the ventilator. Connect the electrical power cord to a properly grounded electrical outlet. Turn the ventilator power ON/OFF switch to the ON position.

3.2.10.2 Set the controls as follows for Time Cycled - IMV/CPAP:

Inspiratory Time –	1.0 Seconds
Breath Rate –	0.
Peak Flow –	To generate 60/70 cmH_2O
High Pressure Limit –	80 cmH_2O
PEEP/CPAP –	5 cmH_2O

3.2.10.3 Set the controls as follows for Volume Cycled - Assist/control or SIMV/CPAP:

Tidal Volume –	To generate 60/70 cmH_2O
Breath Rate –	.0
Peak Flow –	40 LPM
High Pressure Limit –	80 cmH_2O
PEEP/CPAP –	5 cmH_2O

3.2.10.4 Plug the patient wye and the exhalation valve outlet.

3.2.10.5 Press the manual breath button.

3.2.10.6 Pressure should rise and not decay more than 10 cmH_2O in a two second period. If pressure decays more than 10 cmH_2O in two second period check the patient circuit and humidifier module for leaks and then re-test.

3.2.11 Setting Language Select Switch

The Language Select Switch is located on the lower left-hand corner of the main printed circuit board. The switch is labelled "SW 503" and incorporates four (4) switches labelled "1," "2," "3," and "4." When a switch is in the down position (toward the word OPEN), the switch is OFF and when the switch is in the up position, the switch is ON.The following table indicates the required settings for the various available languages.

SWITCH	1	2	3	4
English	OFF	OFF	OFF	OFF
German	ON	ON	OFF	OFF
French	ON	OFF	ON	OFF
Spanish	OFF	ON	ON	OFF
Japanese	ON	ON	ON	ON

Any other combination of settings results in an illegal setting which will default to the English language.

3.2.12 Setting Apnea Interval Select Switch

The Apnea Select switch is located on the lower left-hand corner of the main printed circuit board. The switch is labelled "SW 504" and incorporates eight (8) switches labelled "1," "2," "3," "4," "5," "6," "7," and "8." Only switches "1," "2," and "3" govern the Apnea setting ("4" and "8" govern the Service Diagnostic Tests and "6" and "7" are unused). When a switch is in the down position (toward the word OPEN), the switch is OFF and when the switch is in the up position, the switch is ON.

The following table indicates the required settings for the various available apnea intervals.

SWITCH	1	2	3
20 seconds	Off	Off	Off (Factory Setting)
40 seconds	On	On	Off
60 seconds	On	Off	On

Any other combination of settings results in an illegal setting which will default to 20 seconds.

3.2.13 Setting Monitor Scan Function Select

The following table indicates the required settings for the scan function.

SWITCH	5
Scan enabled	On (Factory Setting)
Scan disabled	Off

3.3 OVERVIEW OF THE V.I.P. BIRD VENTILATOR SYSTEM OPERATION

3.3.1 Pneumatic Theory of Operation

❒ Introduction

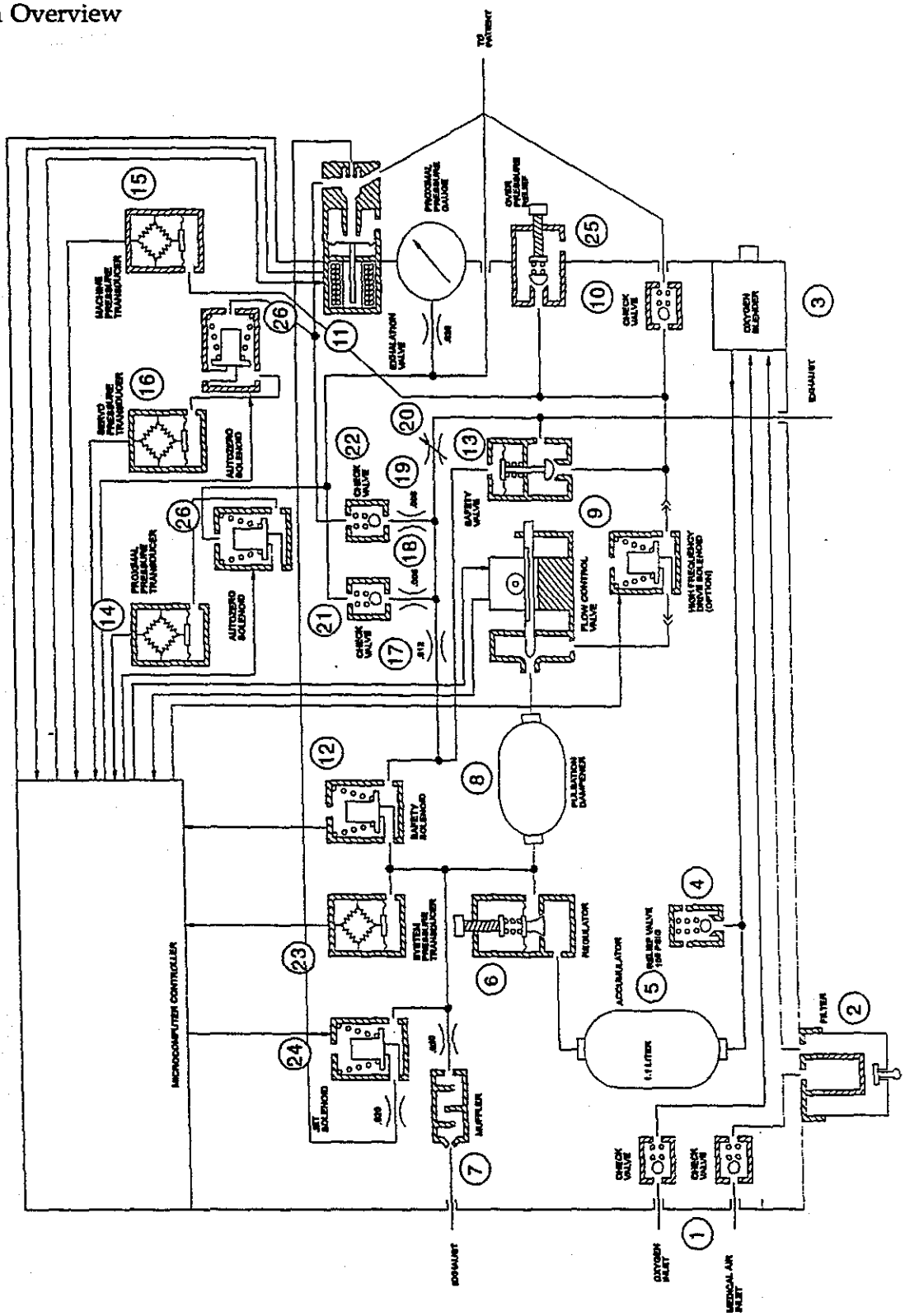
The V.I.P. BIRD is an electronically controlled, pneumatically actuated ventilator capable of supporting most of the current modes of ventilation used for infant and pediatric patients. The electronic control system is based on three microprocessors: The system control processor (CPU A), The acquisition processor (CPU B), And the data display processor (CPU C). The system control processor controls the overall system control functions such as breath rate timing, volume control, flow and exhalation valve servo functions. The data acquisition processor reads and controls analog inputs such as front panel control settings and pressure transducer readings, data reduction for monitoring, and alarm condition testing and monitoring. The data display processors controls the visual output of information to the front panel displays, data reduction for monitoring and transmitting data on the fiber optic link.

The pneumatic system is based on two main electro-mechanical valves, the flow control valve and the exhalation control valve. All gas delivery to the patient is controlled by the flow control valve while all exhaled flow from the patient is controlled by the exhalation control valve.

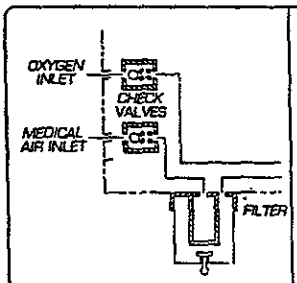
NOTE ✍

Refer to the system overview schematic in figure 3.3.1, page 3-26, for an overview of the system layout.

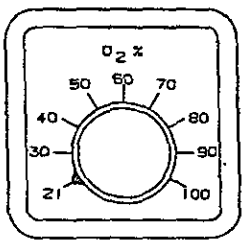
Figure 3.3.1
System Overview



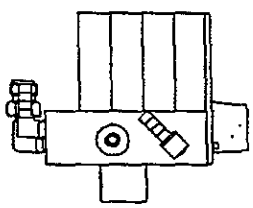
❒ Components



GAS INLET FILTER (1): Compressed medical grade air and oxygen at a range of 40 to 75 PSIG (2.8 to 5.3 kg/ cm2) are connected to the rear of the ventilator (1). The two gas sources enter through the diameter indexed **(DISS)** air and oxygen inlet connectors. Each internal inlet incorporates a 30 micron particulate filter. From the filters the gases travel through the duckbill check valves which prevents possible reverse gas flow from either the air or oxygen supply systems. The incoming compressed air passes through a Coalescing Filter (2) which removes both liquid and solid contaminant particles from the gas stream. The liquid contaminants are collected in the filter bowl where it is visible to the user.The solid particle contaminates are collected on the inside of the Coalescing 5 micron Filter. A drain is provided for the removal of the liquid contaminants.



OXYGEN BLENDER (3): The 10160 MicroBlender provides precise oxygen concentrations by means of a single control. The MicroBlender mixes medical grade compressed air and oxygen to provide a pressurized gas source ranging from 21% to 100% oxygen.



BALANCE MODULE: The two gases then enter the two stage Balance Module. The purpose of this module is to equalize the operating pressures of the air and oxygen gas sources before entering the Proportioning Module.

The diaphragms responds to the difference in pressure and directs the movement (stroke) of each ball valve assembly contained within the air and oxygen chambers. The movement of each ball valve assembly adjusts the amount of gas flowing through the Balance Module, equalizing the air and oxygen pressures.

PROPORTIONING MODULE: From the Balance Module the gases flow into the Proportioning Module and are mixed according to the oxygen percentage selected on the external control knob. The Proportioning Module consists of two valve stems positioned between the front and rear valve seats. One valve seat and stem controls the passage of air and the other valve seat and stem controls the passage of oxygen into the MicroBlender outlet. At this point, the two gases have been blended according to the oxygen percentage selected on the MicroBlender control knob.

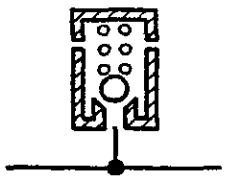
OXYGEN BLENDER (3) (CONTINUED):

PROPORTIONING MODULE (Continued): With the control knob in the full counter-clockwise position (21%) the rear valve stem will completely close off the flow of oxygen, allowing only the air to flow. By adjusting the control knob to the full clockwise position (100%), the flow of air is blocked, permitting only the flow of oxygen through the MicroBlender outlet.

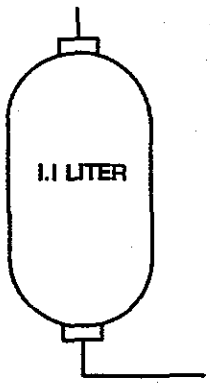
ALARM/BYPASS: The alarm feature provides for an audible alarm if source pressures differ by 20 PSIG (1.4 kg/cm2) or more. The primary purpose of the alarm is to audibly warn the operator of an excessive pressure drop or depletion of either source gas. The alarm will also activate in the event of elevation of either source gas when a difference of 20 PSIG (1.4 kg/cm2) or more is seen. Should both gas pressures increase or decrease simultaneously, and a 20 PSIG (1.4 kg/cm2) differential is not seen, there will not be an audible alarm. If either source gas pressure drops, the output pressure of the MicroBlender will drop similarly, since the source gases are always balanced to that of the lower pressure.

The bypass function operates in unison with the alarm. The alarm bypass poppet communicates directly with the air supply on one end and the oxygen supply on the other. When the two source gases are near equal in pressure, the alarm bypass poppet is positioned over the bypass channel, blocking the flow of both gases. The poppet will remain positioned for unequaled pressures up to 20 PSIG (1.4 kg/cm2) Once a 20 PSIG (1.4 kg/cm2) difference is sensed by the poppet, the higher gas pressure will overcome the spring force and pressure at the opposite end, thus creating a path for gas (air or oxygen) to flow into the alarm channel.

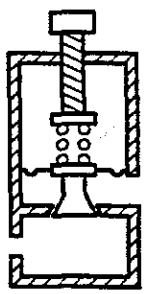
The gas with the higher pressure will also flow directly to the MicroBlender outlet port bypassing the Balance and Proportioning Modules. The gas is also directed to the reed alarm, thus creating an audible warning. The oxygen concentration will be that of the gas at the higher pressure. The MicroBlender in the alarm/bypass mode will deliver the oxygen (100%) or air (21%) until the bypass mechanism resets when source gas pressure is restored to a differential of approximately 6 PSIG (0.42 kg/cm2).



RELIEF VALVE (4): The Relief Valve (4) vents inlet gas to ambient if the inlet pressure to the accumulator exceeds 100 PSIG (7.03 kg/cm2). This protects the pneumatic system in the event excessive inlet pressure is applied to the ventilator.



ACCUMULATOR (5): Filtered and blended gas passes into the 1.1 liter Accumulator (5). The purpose of the Accumulator is to store pressurized gas for augmenting the MicroBlender flow during high inspiratory flow demands. The Bird 10160 MicroBlender is capable of delivering approximately 75 LPM with inlet and outlet pressures of 50 and 35 PSIG (3.5 and 2.46 kg/cm2) respectively, while the ventilator can deliver flow rates up to 100 LPM. This extra flow capacity is provided since the Accumulator is a rigid vessel, charging and discharging is accompanied by large pressure variations as shown in the Figure 3.3.2.

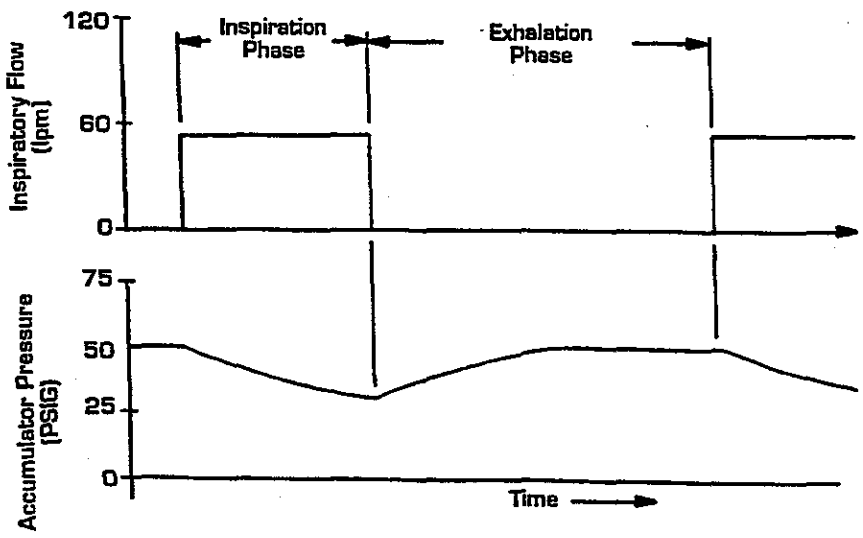


REGULATOR (6): A precision pneumatic Regulator (6) establishes the system pressure at 25 PSIG (1.75 kg/cm2). This pressure is used for the following functions:

a) A precise stable gas supply to the Flow Control Valve for purposes of accurate flow control.

b) Driving pressure for the proximal and exhalation valve (servo) pressure line purge functions.

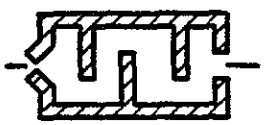
Figure 3.3.2



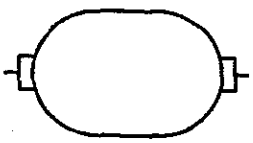
REGULATOR (6) (Continued:

c) Pilot pressure for actuating the safety valve.

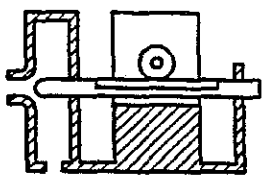
d) Driving pressure for the exhalation jet venturi system.



BLENDER BLEED SYSTEM (7): A continuous bleed of approximately 6 LPM is maintained to assure blender accuracy during low flow states. This bleed is maintained through the accumulator to enable a continuous "FLUSH" of gas, enhancing the systems response to changes in FIO_2.



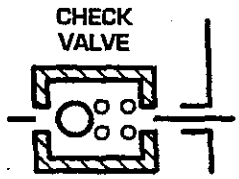
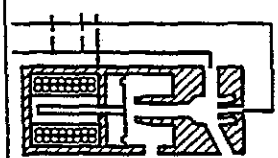
PULSATION DAMPENER (8): The Pulsation Dampener (8) is a rigid chamber with a volume of approximately 200 ml. The Flow Control Valve is capable of very fast changes in gas flow which in turn forces the Regulator to respond rapidly in order to maintain a constant system pressure. During these transient flow conditions, pressure fluctuations occur due to the response time of the Regulator. The Pulsation Dampener acts as a buffer between the Flow Control Valve and the Regulator thereby minimizing the pressure fluctuations.



FLOW CONTROL VALVE (9): Gas flow to the patient is controlled by the Flow Control Valve (9). The valve is an electro-mechanical device. Rotary motion of the electro-mechanical driver is transformed to the linear motion which is required for throttling flow through the variable poppet type orifice. The valve is designed and calibrated to obtain a known relationship between position and orifice opening. With the system pressure at 25 PSIG (1.75 kg/cm2), flow through the variable orifice is sonic up to a downstream pressure of approximately 5 PSIG (0.350 kg/cm2) or approximately 350 cmH_2O. This causes the mass flow through the valve to be unaffected by downstream patient circuit pressures. This combination of features leads to a known relationship between the electro-mechanical driver position and flow rate which is used by the Microprocessor Controller to control flow and volume to the patient. The range of the valve is 0 to 100 LPM with an approximate resolution of 0.1 LPM. An optical sensor detects and verifies the zero flow position. The volume delivered to the patient circuit, when corrected to body temperature (37°C), equals the Tidal Volume control setting

The following chart describes the method of flow delivery for the various breath types.

Breath type	Method of Inspiratory Flow Delivery
Volume Controlled	Using the known relationship between valve position and flow rate, the Microprocessor Controller moves the valve in a predetermined sequence to satisfy the tidal volume and peak flow setting.
Spontaneous	Using feedback from the proximal and exhalation valve (servo) pressure transducers, the Microprocessor Controller moves the valve to provide flow as required to maintain a stable PEEP/CPAP pressure.
Pressure Support	Identical to spontaneous breath except the inspiratory flow is controlled to the Pressure Support setting plus the PEEP/CPAP setting.
Time Cycled	Maintains a constant flow during inspiration per the Flow Control input.

	*CHECK VALVE (10):* The Check Valve (10) is included to insure one way gas flow when the patient is breathing spontaneously. On the exhalation leg of the patient circuit, the Exhalation Valve Diaphram also functions as a one-way check valve. One way flow is critical when the patient is breathing through the Safety Valve (13) with the ventilator in an inoperative condition.
	*EXHALATION VALVE (11):* All exhaled gas from the patient is controlled by the Exhalation Valve (11). The Exhalation Valve poppet is controlled by an electro-mechanical actuator under closed loop control of the Microprocessor.

EXHALATION VALVE (11) (Continued): The Exhalation Valve performs the following functions under Microprocessor Control:

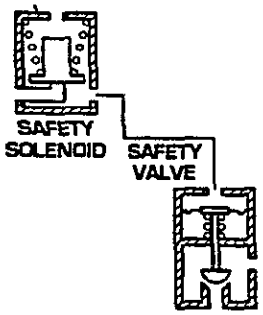
a) Closes the exhalation leg of the patient circuit during inspiration for all breath types except Time Cycled Pressure Limited.

b) Servos to the High Pressure Limit level during inspiration of Time Cycled Pressure Limited breaths.

c) Opens wide at the beginning of exhalation for minimum flow resistance.

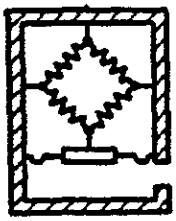
d) In conjunction with the Flow Control Valve (8), Microprocessor Controller, and both the Proximal and Exhalation (servo) (16) Pressure Transducers (14), controls PEEP/CPAP and Pressure Support to the desired level.

e) Opens wide following a High Pressure or Circuit Fault Alarm to allow immediate evacuation of the circuit pressure.



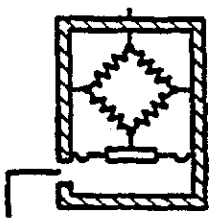
SAFETY SYSTEM (12), (13): The safety system consists of a Safety Solenoid (12) that drives the main Safety Valve (13). During normal operation the solenoid is open, passing 25 PSIG (1.75 kg/cm2) system pressure to the upper Safety Valve Chamber. This closes the safety valve poppet and seals the inspiratory leg of the patient system.

When electrical power is lost or the unit is in a ventilator inoperative condition, the Safety Solenoid closes, venting the upper chamber of the Safety Valve to ambient pressure. This opens the Safety Valve poppet allowing the patient to inspire spontaneously from room air.

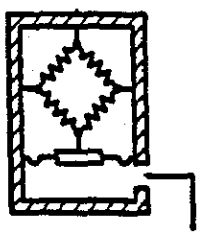


PROXIMAL PRESSURE TRANSDUCER (14): The Proximal Pressure Transducer (14) converts proximal airway pressure to an electrical analog signal. This signal, which is generated every 2 milliseconds, is used by the Microprocessor Control System for the following functions:

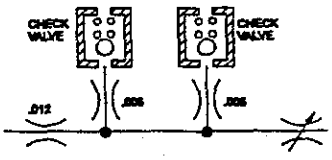
- Primary servo system pressure data source
- PEEP/CPAP control
- Leak compensation
- Assisted breathing
- Pressure Supported breathing
- High Pressure Limit alarm
- Low Peak Pressure alarm
- Low PEEP/CPAP alarm
- Apnea alarm
- High/Prolonged Pressure alarm



MACHINE PRESSURE TRANSDUCER (15): The Machine Transducer (15) monitors machine outlet pressure every 2 milliseconds. This transducer is used as a safety monitor to the Proximal Pressure Transducer. During certain phases of inspiration, the Microprocessor Controller compares the two pressures signals. The two signals must agree within the predetermined tolerance band which allows for transducer tolerances and differences in pressure readings caused by pressure drops in the patient circuit inspiratory leg. If this test fails, the unit sounds an audible/visual alarm.

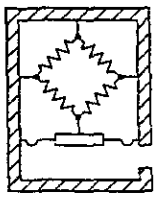


EXHALATION VALVE (SERVO) PRESSURE TRANSDUCER (16): The Exhalation Valve Pressure Transducer (16) is used in conjunction with the Exhalation Valve to control PEEP/CPAP for all breath types, and peak inspiratory pressure for Time Cycled Pressure Limited breaths. A pressure signal is generated every millisecond.



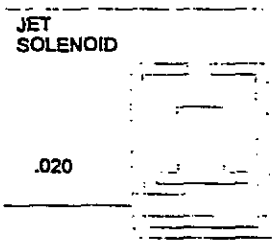
PROXIMAL AND EXHALATION VALVE PRESSURE SENSING LINE PURGE (17), (18), (19), (20), (21) AND (22): The Proximal and Exhalation Valve Purge provides a forward flow of blended gas through the Proximal Airway and Exhalation Valve Pressure Sensing lines. This prevents moisture from migrating up into the ventilator pneumatics.

The three fixed orifices (17), (18) and (19) and the variable orifice (20) are calibrated to provide .05 - .10 LPM purge flow. The check valves (21) and (22) prevent back flow into the pneumatic system in the event patient circuit pressure exceeds the purge drive pressure.

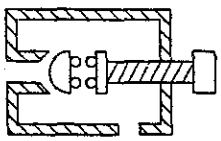


SYSTEM PRESSURE TRANSDUCER (23): The System Pressure Transducer (23) monitors the 25 PSIG (1.75 kg/cm2) system pressure every 32 milliseconds and converts it to an electrical analog signal. This signal is compared to a predetermined tolerance range. If the system pressure is out of range, the controller will activate the Low Inlet Gas Pressure alarm or Ventilator Inoperative state depending on the severity of the out of range condition. The following conditions can cause the system pressure to be out of range:

- Insufficient gas supply
- Clogged inlet filters
- Regulator out of calibration
- Oxygen blender malfunction



JET SOLENOID (24): The Jet Solenoid (24) is used to control the drive pressure to the exhalation valve jet venturi. This solenoid will activate during Time Cycled Pressure Limited ventilation only. Under closed loop Microprocessor control, the solenoid is activated as required to overcome the inadvertent PEEP created by continuous flow through the exhalation leg of the patient circuit.



OVER-PRESSURE RELIEF VALVE (25): The Over Pressure Relief Valve (25) is purely a mechanical back up to the High Pressure Limit function. Adjustable from 0 to 130 cmH2O, the valve relieves the pressure through the inspiratory leg of the patient circuit at the users set value. In Time Cycled IMV/CPAP, the Over Pressure Relief Valve should always be set greater than 15 cmH2O above the High Pressure Limit control setting. If the Over-Pressure Relief Valve is set below this, it may prevent the High/Prolonged Pressure alarm from activating and will not be vented back through the Safety Valve in the event of an expiratory leg occlusion. In the Volume Cycled modes (Assist/ Control or SIMV/CPAP), the Over-Pressure Relief Valve should always be set greater than 5 cmH2O above the High Pressure Limit alarm setting. If set below this, it may prevent the High Pressure Limit alarm from activating and pressure will not be vented back through the Safety Valve in the event of an expiratory leg occlusion.

Auto Zero Manifold Theory (26): The Auto Zero Manifold is used in the VIP to zero the drift on the Proximal and Exhalation transducers. This is done so the patient effort does not become more difficult as the transducers drift. The Auto Zero Manifold will be active in those ventilators that have the dip switch SW504 locations 6 & 7 turned to the ON position. The Auto Zero Manifold will zero the transducers immediately after power up, after 5 minutes, then every 30 minutes for the next three hours. After the third hour it will activate every three hour.

3.3.2 Electronic Theory of Operation

Introduction

The electronic package of the VIP BIRD ventilator consists of individual electronic components and three Printed Circuit Board Assemblies (PCBA's). These assemblies are the DISPLAY PCBA, MAIN PCBA, and POWER/DRIVER PCBA.

The Power Entry Module, Power Transformer, and Alternate Power Input supply the electrical energy used by the ventilator. The Power/Driver PCBA conditions the electrical power for use by the remainder of the electronics. This PCBA also contains the special analog constant current for the step motor actuated Flow Control Valve and linear solenoid actuated Exhalation Valve. The solenoid valves include: 1 jet pump valve, the safety solenoid valve; 2 auto zero valves. The Hourmeter is also driven from this PCBA. The Power Driver PCBA can be easily upgraded as required.

The function of the Display PCBA is to provide visual information feedback to the user and to accept some switch selected inputs from the user. Mounted on the Display PCBA are up to 49 numeric display digits, an 8 character alphanumeric display, up to 27 LED indicators, and up to 8 push button switches. The display and indicators inform the user of ventilator status, ventilation parameters, and control settings. The push button switches allow the user to select, activate or adjust various functions of the ventilator. Also on the Display PCBA is the Alarm Volume Control. The Display PCBA contains one microcontroller system referred to as "CPU Unit C." This CPU controls the operation of the display devices and monitors the switches for inputs from the user. Note that there are rotary switches and control potentiometers mounted to the back side of the Main PCBA such that the parts pass through holes in the Display PCBA and may appear to be part of the Display PCBA.

The function of the Main PCBA is to collect and process data from the control potentiometer, switches, and pressure transducers in order to develop control signals to be sent to the Power/Driver PCBA to dictate the action of the Flow and Exhalation valves and the various solenoid valves. The Main PCBA contains two complete microcontroller systems referred to as "CPU Unit A" and "CPU Unit B." These CPU units are in constant communication with each other and also with "CPU Unit C" on the Display PCBA.

Also mounted on the Main PCBA are Pressure Transducers, the Audible Alarm, and up to 3 Fiber Optic Transmitters, up to 2 Fiber Optic Receivers, 2 sets of DIP Switches, and connectors for the Power/Driver PCBA. Rotary switches and control potentiometers are mounted to the back side of the Main PCBA such that the parts pass through holes in the Display PCBA and may appear to be part of the Display PCBA.

☐ Individual Electrical Components

POWER ENTRY MODULE: The Power Entry Module is mounted on the rear panel of the ventilator. It consists of an I.E.C. power inlet connector, a medical grade EMI filter, a fuse holder for two 5mm fuses or one 1/4" inch fuse, and a four position line voltage selector. This allows the VIP BIRD to be used world wide by installing the correct fuse(s), adjusting the voltage selector to the correct setting, and selecting the appropriate power cord set. Note that unlike the power entry module used on the 6400st and the 8400st ventilators, the VIP BIRD power entry module does not have an integral power ON/OFF (I/O) switch. The primary side of the power transformer is always powered whenever the power cord is plugged in.

POWER TRANSFORMER: The Power Transformer is mounted to the casting over the accumulator tank and near the Power Entry Module. The transformer primary windings are arranged with multiple taps to accept the various input voltages selected by the Power Entry Module voltage selector. The secondary winding of the transformer provides a nominal 12 VAC to the power supply section of the Power/Driver PCBA to power the ventilator. Since there is no ON/OFF (I/O) switch in the Power Entry Module, the primary side of the Power Transformer is always powered whenever the power cord is plugged in. Over-current protection is provided for the primary side of the transformer by the fuse(s) in the Power Entry Module.

ALTERNATE POWER INPUT: The Alternate Power Input is located on the rear panel of the ventilator. It consist of a 3-pin male connector, an EMI filter, and a switch to select normal AC line power or the alternate power source. When the switch is in the "UP" position the normal AC line power is selected. When the switch is in the "DOWN" position the alternate power source is selected. The alternate power source must be a DC voltage between 12 and 16 VDC and capable of supplying up to 5 amperes. Over-current protection for alternate power source is supplied by the circuit breaker.

3.4 CLEANING AND STERILIZATION

3.4.1 Cleaning

CAUTION ✔

Under no circumstances should the main flow or proximal line bacteria filters ever be cleaned internally. The external surfaces may be wiped clean using the appropriate bactericidal or germicidal agent. Care should be taken not to allow the liquid agents to penetrate the inside of the bacteria filters.

NOTE ✍

Following each patient use, or more frequently if necessary, it is important to clean the exterior of the ventilator as well as the various components of the patient circuit system.

❒ **Ventilator**

The exterior of the ventilator may be wiped clean with an appropriate bactericidal or germicidal agent. Care should be taken not to allow the liquid agent to penetrate the inside of the ventilator. Do not spray any liquid agent directly on the control panel.

- **DO NOT** use harsh abrasives on ventilator.
- **DO NOT** immerse ventilator in liquid sterilizing agents.
- **DO NOT** sterilize ventilator.

❒ **Patient Circuit System**

The patient circuit system should be cleaned using a warm detergent solution. All parts should then be thoroughly rinsed in warm water and prepared for sterilization.

To disassemble and reassemble the Exhalation Valve Assembly, complete the following steps listed below:

- Press and hold down the gray locking tab on the lower left of the exhalation valve body.

- Grasp the exhalation valve body gently and rotate it counter-clockwise until the tabs and slots line up and the valve body can be removed.
- To remove the diaphragm, grasp the center tab gently and pull diaphragm out.
- After cleaning and sterilization, replace the diaphragm by holding the tab in the center of the diaphragm and seating it into the receptacle. Tap gently around the parameter of the diaphragm to insure proper seating.
- Line up the tabs on the exhalation valve body with the slots on the receptacle. Gently push in and rotate the exhalation valve body clockwise until the gray locking tab on the lower left pops out.
- Pull out gently on the exhalation valve body to insure that it is engaged.

3.4.2 Sterilization

Once the various components have been cleaned and rinsed, they may be prepared for the appropriate method of sterilization. The most frequent methods of sterilization are gas (Ethylene Oxide), liquid (Cidex, Sonacide, etc.), pasteurization, or autoclave (steam).

Recommended Guidelines for Sterilization:

Component	Frequency	Method
Bacteria Filters	Between patient use	Steam autoclave
Patient Circuits	Every 24 hours or per hospital protocol	Gas, Liquid, Pasteurization, or Autoclave

NOTE

For additional information on cleaning and sterilization of Bird Products Corporation Heated Humidifier or 3800 Microblender please refer to the following literature:

L1001 - Heated Humidifier Instruction Manual

L1008 - 3800 MicroBlender Instruction Manual